Comparing the Efficacy of Tablet PC and Teacher Presented Educational Material on the Maintenance of On-Task Behavior for Children with Autism

By

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Youngstown State University

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Comparing the Efficacy of Tablet PC and Teacher Presented Educational Material on the Maintenance of On-Task Behavior for Children with Autism

Zachary F. Vargo

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Abstract

Tablet PCs (TPC) have been reported in the popular media as useful teaching tools for individuals diagnosed with autism. However, there has been little empirical research demonstrating this usefulness. Many children with autism have communication deficits including lack of eye contact, lack of affect, and poor receptive skills that may make teacher presented educational materials less effective than TPC presented educational material. The current study compared TPC presented educational material to teacher presented educational material with three children diagnosed with autism. In an alternating treatment design TPC presented educational material was found to result in more attempted problems, more correct responses, and less off-task behavior when compared to teacher presented educational material.

DESCRIPTORS: autism, TPC, tablet PC, iPad, application, app, on-task, off-task
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Comparing the Efficacy of Tablet PC and Teacher Presented Educational Material on the Maintenance of On-Task Behavior for Children with Autism

Autism Spectrum Disorders (ASD) are a group of neurodevelopmental disorders that have overlapping diagnostic criteria related to deficits in communication, socialization, restricted interests, and repetitive behaviors (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000). Many children with Autism Spectrum Disorder (ASD) experience social anxiety (Chang, Quan, & Wood, 2012), show very little interest in academic assignments, and exhibit disruptive behavior when assignments are presented (Koegel, Singh, & Koegel, 2010). The issues presented above can make it more difficult for teachers to present educational material to students with ASD.

Fortunately, computers are a familiar and enjoyable medium for many children, including children with autism, and may offer potential as a means of facilitating education for children with ASD. In recent years, computers have been used effectively with children with ASD as an instructional method (Barrow & Hannah, 2012).

**Tablet PCs**

Modern touch screen tablet PCs (TPC), such as the iPad®, were introduced in April, 2010 and have been publicized by many media sources as a useful teaching tool for individuals diagnosed with autism. TPCs are essentially laptop computers contained in a single panel. They are distinguished from a desktop computers or laptops by the use of a touch screen as an input device and the lack of a physical keyboard. Modern tablets are operated by fingers or a pen-like stylus.

*60 minutes* (2011), an investigative news and television program, dedicated an episode on the usefulness of the TPC as a functional communication tool for
nonverbal individuals with autism. Autism Speaks (2012), a world leading autism science and advocacy organization dedicated to research into the cause, prevention, treatment and cure for autism, has website links for tablet PC applications promoted by parents of children with autism to improve various educational and social skills. Many news outlets such as Fox News, CNN, and ABC News have articles touting the “amazing” results of using TPCs with children diagnosed with autism (Baker, 2012; Seshadri, 2012; Alfonsi, 2010). While the reported success of TPCs is extensive in the popular media, very little empirical research has been published showing the effects of TPCs in an instructional setting with any student population, and much less for children with autism (Enriquez, 2010).

**Computer Based Instruction**

Unlike TPCs, traditional desktop computers have been previously identified as useful teaching instruments for children with autism. In a school setting, computers were found to be beneficial in the treatment of communication deficits such as echolalia (Hetzroni & Tannous, 2004). Following the study, all participants showed fewer sentences with delayed and irrelevant speech. Travers, Higgins, Pierce, Boone, Miller and Tandy (2011) compared computer assisted instruction and teacher led instruction to teach alphabetic skills for a group of preschool students with autism. They found that there were no significant differences between the two instruction methods for student attention or rates of undesirable behavior and that both methods significantly raised the participants’ collective ability to recognize letters of the alphabet. A meta-analysis of 254 studies conducted by Kulik and Kulik (1991) showed that computer-based instruction (CBI) usually produces positive effects on students. Participants in these
studies consisted of kindergarten to adult learners. Of the 254 studies identified, 202 reported that students in the CBI class had the higher examination average. The meta-analysis also reported that CBI produced small but positive changes in student attitudes toward teaching and computers and it reduced the amount of time needed for instruction. These results demonstrate the effectiveness of computers as instructional tools.

A study by Plienis and Raymond (1982) compared teacher and computer delivered instruction for children with severe learning and behavior problems, and found that whether instruction is delivered by a teacher or a computer, the actual performance of these students was the same. However, more deviant behavior was exhibited during teacher conditions. Higgins and Boone argued that these results are similar to those from other studies involving students with disabilities when computers were used to provide instruction either as a supplement to, or as a substitute for teacher-directed instruction.

Computers and TPCs provide immediate feedback on correct responses and show students how to correctly answer questions. As a result, students are less likely to practice incorrect skills. Students using computers tend to engage in work that results in the presentation of more immediate and higher rates of feedback. These same students are more likely to engage because they are reinforced for on-task behavior and work completion (Haydon, Hawkins, Denune, Kimener, McCoy, & Basham, 2012). Kodak, Fisher, Clements, and Bouxsein (2010) found that correct responding was similar across computer-assisted instruction and one-on-one instruction, but also found that computer assisted instruction was effectively administered by nearly all inexperienced instructors (90-100%) whereas only 60% of these same instructors were effective in administering
one-on-one instruction alone (i.e., without computers). These results suggest that a computer based educational material can have a higher overall presentation integrity.

**Off-task and On-task behavior**

Off-task behavior is an issue in all schools, but due to the behavioral characteristics of ASD (communication deficits, inattentiveness, lack of eye contact, lack of affect, and poor receptive skills), off-task behavior is a fundamental problem when teaching students with autism. Managing inappropriate behaviors and classroom disruptions is time consuming and takes away from valuable instructional time when students could be engaging in academic behaviors. Students who frequently engage in off-task and inappropriate behaviors disrupt the classroom environment and hinder learning of all students in the classroom (Riley, McKevitt, Shriver, & Allen, 2011). Teachers working with these students need effective strategies to increase student compliance, facilitate academic behaviors, and reduce off-task and inappropriate classroom behaviors as well as disruptions (Troutman & Alberto, 2003).

An intensive amount of one-on-one individualized instruction is required for students with autism. If TPC-delivered instruction is as, or more, effective than instruction delivered by the teacher (Williams, Wright, Callaghan, and Coughlan, 2002), then TPCs may be effective tools for reinforcing or practicing skills currently being taught by the teacher. This means that teachers of students with autism may have another tool, TPCs, with which to provide effective instruction. When comparing the effects of traditional book based instruction to computer based instruction on reading, Williams et al. (2002) found that children with autism spend more time on reading material when they accessed it through a computer and were less resistant to its use.
Although traditional desktop computers have been previously identified as useful teaching tools for children with autism, TPCs, while popularly promoted, have not been shown empirically to be effective teaching tools. However, preliminary evidence is promising. For example, Davis (2011) found that students are using an increasing number of TPC applications to improve social skills and communication. These applications can be used by individuals who cannot attend a traditional classroom to learn addresses, phone numbers, and other basic information, use games to improve balance and coordination, aid communication, and even prepare for a trip to the dentist. Many of these applications are currently available with more in development.

Schools and those who provide intervention for students are seeking out TPC technology and the applications it can offer. As the number of students with autism increases, TPC based instruction is likely to become more widespread. According to the U.S. Department of Education (2004), there was a 1,700 percent increase in the number of students with autism enrolled in schools from the 1991-92 school year through the 2001-02 school year, compared with a 30 percent increase among all other disabilities. Currently, one in 88 U.S. children is diagnosed with autism by the time they are eight years old (Centers for Disease Control and Prevention, 2008).

Although, TPCs have become popular household items and are making their way into more schools and other places of learning their effectiveness as teaching tools needs to be established. Before TPCs should be used as teaching tools it is important to see what effects, if any, TPCs have on the behavior of children with ASD. Therefore, the purpose of the current study was to compare TPC presented educational material to teacher presented educational material to determine the relative effectiveness of each to
maintain on-task behavior and correct responding in a school setting for children diagnosed with autism. A second purpose of this study was to replicate and extend the findings of previous studies that used traditional computers as educational tools by using TPC as the medium for presentation of educational material to children with autism.

**Methods**

**Participants, Setting, and Materials**

The participants in this study were three male students ages twelve to fourteen from a pre-kindergarten through high school educational program for children with autism in Northeastern Ohio. All participants had previous experience with TPCs as both educational and as entertainment devices. Teachers and classroom supervisors assisted with the identification of students to participate in the study. The only criteria given for student participation was that the students not be part of any other experimental process.

Sessions took place in a classroom (10 ft. by 10 ft.) containing a table with two chairs and arranged to minimize distraction. The student sat in a chair in front of the table and next to a teacher who presented work tasks. Sessions lasted ten min. and were conducted two-four times per week with each student. Each ten min. session consisted of a single presentation method (TPC or teacher).

The materials used in this study included a tablet pc (iPAD®) which was used to display developmentally appropriate educational material (applications), a stop watch to record the duration of on-task behavior, work sheets designed specially for this experiment (described below), a digital video recorder (Nikon D700 in video mode) and tripod, data recording sheets to record the number of correct and incorrect responses, and writing utensils. Guided access, a feature that locks the home button, volume buttons,
TABLET PC AND TEACHER PRESENTED MATERIAL

and on/off button on the TPC, was used during the TPC presentation conditions. This restricted access on the TPC so that only the presented application was available.

**Assessments.** The experimenters of this article intended to assign different applications to each participants based on their developmental and functional skill levels (color matching, shape matching, math). The Assessment of Basic Language Learning Skills-Revised (ABLLS-R, Partington, 2006) and the Curriculum-Based Measurement Solutions for Every Tier (easy CBMTM, University of Oregon, 2006-2013) were used to identify the developmental and functional skill level of each participant to ensure appropriate educational material was selected. The results of the ABLLS-R and easy CBMTM showed that all participants performed basic fist grade addition with 70% or greater accuracy. Because all participants demonstrated proficiency in first grade addition only a single application was used. MathtrainerTM, an application developed by Deep River Development Ltd., was used during the TPC presentation conditions. The students had no previous experience with Mathtrainer but they had prior experience with TPCs as educational tools within the classroom, therefore the students did not require any training to use or navigate the application. The application presented math problems and answers in a multiple choice format. The math problem was located at the top of the screen with four possible answers below. The student selected an answer from those presented by tapping one of the answers after which feedback was provided using the words "CORRECT" or "WRONG" at the top of the screen. The student then tapped the word "NEXT" to access subsequent math problems.

The teacher presented material was created using the TPC screenshot feature and the Mathtrainer educational application. Screenshots were printed and laminated so they
could be reused after each presentation. Whiteboard markers were used by students to mark their answers.

**Dependent Variables, Independent Variables, and Measures.**

The dependent variables in this study included the duration of on-task and off-task behavior, the number of attempted problems, and the number of correct responses. On-task behavior was defined as the participant remaining in their seat, having eye contact with the teacher or assigned task, and performing the requested assignment. Off-task behavior was defined as looking away for three or more seconds from the presented educational material or the teacher when instruction was being provided. Off-task behavior also included times when the student made unrelated comments or played with items or clothing. Attempted responses were defined as the total number of both correct and incorrect responses. Correct responses were defined as the identification of or circling of the most accurate answer. The independent variables were the methods of presentation, TPC or teacher, for the assigned tasks.

**Interobserver Agreement**

Interobserver agreement (IOA) was recorded by two independent observers during 39% of all sessions. To calculate the duration of on-task behavior the independent observers used recorded video of each IOA session, a stop watch, and a data recording sheet created for the purpose of this study. Interobserver agreement for on-task behavior was calculated by dividing the lower duration of on-task behavior recorded by the independent observers by the higher duration then multiplied by 100 to show the percentage agreement for each session.
To calculate the number of correct responses and the number of problems attempted for each session, the independent observers used a data collection sheet and permanent product (papers used in the teacher presentation sessions). Interobserver agreement for the number of correct responses was calculated by dividing the lower number of correct responses recorded by the independent observers by the higher number of correct responses then multiplied by 100 to show the percentage agreement for each session. Interobserver agreement for the number of problems attempted was calculated by dividing the lower number of attempted problems recorded by the independent observers by the higher number of attempted problems then multiplied by 100 to show the percentage agreement for each session.

The independent observer also recorded treatment integrity using a checklist created for the purpose of this study (see below) during all IOA sessions. This checklist ensured that the presentation, procedures, and methodology used were the same for all participants. Treatment integrity was calculated by dividing the number of steps on the treatment integrity checklist performed correctly by the number of total steps available then multiplied by 100 to show the percentage of correctly performed steps. Interobserver agreement and treatment integrity was collected for 50% of all sessions for participant 1 resulting in agreement for on-task behavior at 98.5%, for number of attempted problems was 100%, for the number of correct responses was 98.8%, and for treatment integrity was 100%. Interobserver agreement and treatment integrity was collected for 33% of all sessions for participant 2 resulting in agreement for on-task behavior at 99.9%, for number of attempted problems was 100%, for the number of correct responses was 99.3%, and for treatment integrity was 100%. Interobserver
agreement and treatment integrity was collected for 33% of all sessions for participant 3 resulting in agreement for on-task behavior at 98.3%, for number of attempted problems was 100%, for the number of correct responses was 100%, and for treatment integrity was 85.7%. Overall results indicated an agreement for on-task behavior was 98%, for the number of attempted problems was 100%, for the number of correct responses was 100%, and for treatment integrity was 96% across all participants.

Procedure

Each student was asked to complete math problems in both conditions of the experiment. One condition used the TPC educational application. During this condition, the student worked on the assigned task while the teacher recorded the number of correct responses. In the other condition, the teacher presented work assignments tailored to replicate the tablet pc application in paper form. Duration of on-task and off-task behavior was recorded during all sessions using a stop watch and video recording. A video camera (Nikon D700) on a tripod was positioned to record the upper torso and face of participants during all sessions. The video was later transferred to a portable hard drive for storage. During all sessions the role of the teacher was performed by the author of this article.

Tablet PC Delivered Instruction

In both conditions the student sat on a chair in front of the table and was presented with educational material. In the TPC delivered condition the teacher sat in a chair next to the student and placed the TPC on the table in front of the student with the educational application open to the first math problem and gave the instruction to “work on math.” No attention was provided with the exception of redirection when off-task behavior was
observed throughout the session. Redirection consisted of a three-step prompt procedure (Wilder, Myers, Fischetti, Leon, Nicholson & Allison, 2012) 1) point to the assigned task, 2) wait 5 s., if off-task behavior continued, point at the work task and say “work”, and 3) wait 5 s., if off-task behavior continued, pick up the assignment, hold it approximately 12-18 in. away from the student, ensure eye contact is made with the work task, and present the instruction “work on math” and then place the assignment back on the table in front of the student. If work did not continue after 10 s, the three-step prompt procedure was to be presented a second time beginning with the first step. If, after the second presentation of the three-step prompt procedure, work did not continue; the session was terminated. Following any of these steps, if the student returned to the work assignment, the prompt procedure was to start from the first step if off-task behavior occurred again.

**Teacher Delivered Instruction**

During the teacher delivered condition, the teacher sat at the table next to the student and presented the student with math problems. Each problem was presented as a single equation on a sheet of paper and replicated the TPC presented material. The paper problems resembled the TPC presentation by using the same or similar color, font, number of tasks per page, and answer selection methods. Once the problem was completed the teacher removed the paper and presented the student with the next problem. If off-task behavior was identified the 3-step prompt procedure, outlined above, was to be used. Other than redirection and task presentation the teacher gave no other form of attention to the student. Following each teacher presentation session, the number
of correct and incorrect answers were recorded, all marks on the task papers were erased using a whiteboard eraser, and the papers were shuffled in preparation for their next use.

**Experimental Design**

An alternating treatments design (Cooper, Heron, & Heward, 2007, p. 187), was used to compare TPC to teacher presented educational material where A represented the teacher presented condition and B represented the TPC condition. To account for possible confounds and to control for threats of internal validity such as carryover and sequencing effects, one of the participants was randomly assigned to a BABA design.

**Results**

Figures 1 through 3 depict the individual responses for both presentation conditions across all experimental sessions for all three participants. Participants 1 and 2 were presented with the teacher condition first (ABABAB) and participant 3 was presented with the TPC condition first (BABABA).

![Figure 1. Attempted problems, correct responses and duration of on-task behavior for participant 1](image-url)
Participant 1 attempted more problems and answered more questions correctly during the TPC condition ($M = 142; M = 82$, respectively) than during the teacher condition ($M = 103, M = 67$, respectively). He also exhibited similar levels of on-task behavior during both conditions (TPC: $M = 9m 51s$; Teacher: $M = 9m 47s$).
Participant 2 attempted a similar number of problems during the TPC and teacher conditions (TPC: $M = 72$; Teacher: $M = 68$) and correctly answered a similar number of questions during the TPC and teacher conditions (TPC: $M = 64$; Teacher: $M = 62$). However, he was on-task more during the TPC condition than during the teacher condition (TPC: $M = 9m\ 41s$; Teacher: $M = 8m\ 42s$).

Participant 3 attempted more problems and answered more questions correctly during the TPC condition ($M = 135$; $M = 125$, respectively) than during the teacher condition ($M = 92$; $M = 91$, respectively). His on-task behavior was higher during the TPC conditions than teacher conditions (TPC: $M = 9m\ 45s$; Teacher $M = 9m\ 37s$).

Figure 4 summarizes the results of attempted problems and correct responses across all participants and conditions. In the TPC presentation condition 1046 problems were attempted with 814 correct responses (75.7% correct responding). In the teacher presentation condition 788 problems were attempted with 659 correct responses (83.6% correct responding). Thus, many more attempted problems and correct responses occurred in the TPC condition, however in the teacher presentation condition there was a greater percentage of correct responses.
Figure 4. Total attempts and total correct responses for all participants across both presentation conditions.

Figure 5 represents the total duration of off-task behavior across all participants and conditions. The TPC condition resulted in less off-task behavior (2m 38s) than the teacher condition (5m 42s), indicating that for these participants, TPCs maintained more on-task behavior than teachers when academic tasks were presented.
Figure 5. Total duration of off-task behavior across both presentation conditions for all participants.

Discussion

Although TPCs are widely used to aid in the teaching of children with autism, there is little research on their effectiveness. The purpose of this study was to identify whether TPCs or teachers were more effective in maintaining on-task behavior and correct responding for children with autism.

Similar to the findings with traditional desktop computers (Hetzroni & Tannous, 2004; Higgins & Boone, 1996; Plienis & Romanczyk, 1982; Travers et al., 2011), the results of this study revealed that TPCs maintained appropriate on-task behavior slightly more than teachers during the presentation of educational material. Also, TPCs provided more opportunities to respond than in the teacher condition. This may be explained by the shorter inter-response intervals following student responses when tasks were presented on the TPC compared to teacher presentation of materials which is similar to
the finding of Haydon et al. (2012). They found that high school students responded faster when using a TPC. This they attributed to the TPC's immediate feedback and higher rate of problem presentation. In the current study, TPC presented instruction may have been administered more efficiently and with a higher overall presentation integrity than the teacher presented condition. This is similar to the findings by Kodak et al. (2010) where computer assisted instruction was effectively administered by nearly all inexperienced instructors (90-100%) whereas only 60% of these same instructors were effective in administering one-on-one instruction alone (i.e., without computers).

Computers, unlike human instructors, can stay on-task 100% of the time, are not distracted from the teaching task, and do not fatigue or get bored.

While the number of correct responses in the TPC condition was higher than the teacher presentation condition across all participants in this study, the teacher presentation condition resulted in a higher percentage of correct responses across all three participants. Higher overall rates of responding, even with a lower percentage of correct responses, has been argued to be an essential response dimension in generating fluency. Fluency, responding at a high rate with accuracy, has been argued as a critical component of skilled behavior, academic or otherwise (Binder, 1996). Therefore, in terms of developing fluency, a lower initial rate of accuracy may not be viewed as problematic.

**Future Direction**

The higher percentage of correct responses during the teacher presented condition may be partially explained by the participants' likely history of reinforcement. In the current study, the TPC, but not the teacher condition, provided differential feedback for correct responding but neither condition required differential responding following an
incorrect response. However, the students likely had a strong history of social reinforcement for correct responding to teacher presented material but no history of social reinforcement for correct responding on computers. Instead, students likely had a history of non-social reinforcement for rapid responding on computers, "correct" or otherwise (e.g. video games). Therefore, although in the present study the teacher did not differentially reinforce correct responding, due to their history of reinforcement the teacher presented material was nevertheless discriminative of correct responding relative to incorrect responding. TPCs could become discriminative for correct responding if the student was required to respond correctly every time an incorrect response was emitted rather than simply moving to the next problem as the current application was programmed. That is, TPC presented material could become discriminative for correct responding if students were given a history where correct responding on TPCs were differentially reinforced. A future area of study could examine the effects of a response correction procedure on presentation methods.

Limitations

That feedback was presented in the TPC condition, but not in the teacher presentation condition, is a limitation of this study. The TPC presented the participants with feedback in the form of "CORRECT" and "WRONG" printed across the top of the screen following their responses. But the participant received no feedback following a response in the teacher presentation condition. Another limitation was that the number of times a single math problem was presented was not tracked. The math problems were generated randomly by the Mathtrainer™ application but it is unknown if the same problem appeared more than one time per session or across sessions.
The results of this study have identified TPCs to be useful tools for the presentation of academic material to children with autism. This finding helps to establish TPCs as an effective means for teachers to present educational material to their students, perhaps superior to humans. Also, because TPCs are capable of maintaining appropriate on-task behavior they may provide teachers with the opportunity to spend more time working with other students that need one-on-one assistance.
References

http://www.cbsnews.com/video/watch/?id=7385686n


Chang, Y., Quan, J., & Wood, J. (2012). Effects of anxiety disorder severity on social


analysis. *Computers in Human Behavior, 7. 75-94*


Pleasant Hills: Behavior Analysts, Inc.


ERIC Clearinghouse.


Appendix A

Treatment integrity

The following checklist should be completed by the independent observer during each session involving independent observation agreement (IOA).

Student initials: ___________  Observer: __________________________

Date: _______________  Session time: __________ - __________

1. The teacher sat at the table next to the student.  Yes □ No □ N/A □

2. The teacher told the student to work on the assigned task.  Yes □ No □ N/A □

3. The student was redirected using the 3-step prompt procedure.  Yes □ No □ N/A □

4. During the TPC presentation condition, other than the 3-step prompt procedure the teacher did not give any form of attention after the task had been assigned.  Yes □ No □ N/A □

5. During the teacher presentation condition, the teacher only provided attention in the form of the 3-step prompt procedure or giving instruction for the given task.  Yes □ No □ N/A □

6. After two complete cycles of the 3-step prompt procedure the session was ended.  Yes □ No □ N/A □

Total steps implemented correctly: _________________

Comments: ____________________________________________________________

_______________________________________________________________

_______________________________________________________________
Appendix B

Data Collection Form

Participant: ____________________  Academic Task: ____________________

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<th>Observer (initials)</th>
<th>Date</th>
<th>Presentation Type (TPC/Teacher)</th>
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Appendix C

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Zachary Vargo successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 09/10/2012

Certification Number: 987917