The effectiveness of assistive technology (TAP-i*t*® and VizZle®) to enhance progress of young children with autism spectrum disorders

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Abstract

It is known that young children with autism require *specialized support* in order to make educational progress. It has been reported that children with autism are also *visual learners* and that their *interactions with technology are sometimes more motivating than interactions with teachers*. The interactive monitor used for this study was the TAP·i*t*®, (Touch Accessible Platform for Interactive Technology) and the visual learning software used in conjunction with this technology is called VizZle®. This study focused on the use of both of these new technologies by comparing rate of progress in achieving individualized learning goals of *study of 8 randomly selected preschool children with autism* against a previous rate of attainment without the technology tools. The data indicated *progress beyond the target goals and the rate of attainment was higher* than that of growth without the treatment condition. Individual participant results and overall trends are presented and discussed. Although the results are not conclusive they add to the knowledge base.

Keywords: autism, assistive technology, VizZle®, TAP-i*t!*®

Young children who have special needs often need specialized support in order to make progress. The use of assistive technology has been widely recommended by the Council for Exceptional Children (CEC) and Division of Early Childhood (DEC) as an appropriate intervention strategy to use especially with children who have autism spectrum disorders. Recent legislation has formalized the requirements for teams to consider the use of assistive technology in the development of individualized education plans (IEP) for children with disabilities ages 3-21(IDEIA, 2004).

The need for assistive technology intervention during the early childhood years has also been widely documented (Judge, 2008; Mazurek, Shattuck, Wagner, & Cooper, 2011; Moore & Wilcox, 2006; Shane & Weiss-Kapp, 2007). Research has also indicated that children with autism learn best through the use of visuals (Hayes, Hirano, Marcu, Monibi, Nguyen, & Yeganyan, 2010; Shane & Albert, 2008; Shane & Weiss-Kapp, 2007).

A review of the literature related to the PECS®, Picture Exchange System, by Sulzer-Azaroff,Hoffman, Horton, Bondy, and Frost (2009), found that the PECS system was used internationally to provide a functional means of communication for children with autism and communication disorders. PECS provides a visual medium for communication and was used by the program that was involved in the current research study therefore aspects of the program (transition cards) were incorporated into the study in order to provide consistency for the participants.

"Touch Accessible Platform Interactive Technology" (TAP-i*t*®) is an interactive white board system which allows children to actively participate in learning activities (SmartEd Services, 2012). TAP-i*t*® is different from other touch screens and smart boards because it is an interactive system that recognizes the difference between intentional touch and accidental touch.

According to the SmartEd Services (2012), TAP-i*t*® is the "first ADA compliant interactive learning station designed to recognize the difference between an arm resting upon the screen and a finger or assistive device intentionally tapping an image." The TAP-i*t*® screen may be rotated between zero and ninety degrees to meet the needs of students in wheelchairs or using other physical assistive devices. TAP-i*t*® is durable and portable, and can also be used with any software program in order to meet the individual needs of children (SmartEd Services, 2012). And can accommodate children who have motor impairments. TAP-i*t*® is ideal for implementing individualized lessons (SmartEd Services, 2012).

VizZle® (Visual Learning) is an online program which provides learning activities that are based upon a child's developmental level and individual needs (Monarch Teaching Technologies, Inc., 2012). VizZle® allows users to create lessons, make playlists of lessons for each child and use the previously created lessons in the online library (Monarch Teaching Technologies, Inc., 2012). Pictures of children's' favorite objects or images of family members can be uploaded to use later to further individualize lessons and increase motivation (Monarch Teaching Technologies, Inc., 2012). A unique feature of VizZle® is that it can track progress on IEP goals and objectives and provide reports. The program can also be used with various devices such as computers, iPads, or smart boards. VizZle® has been presented with several awards, including Best in Tech, 2011 and Tech & Learning Awards of Excellence, 2010. As a new product, there is little longitudinal evidence showing its efficacy as a teaching tool. However, literature points to the importance of visual learning and the intense interactions with whiteboards and computers that children with autism can experience (Shane & Albert, 2008; Moore & Calvert, 2000). Moore and Calvert (2000) found that children with autism were a great deal more attentive to the same lesson presented on the computer (97% of the time) than a

teacher-directed lesson with the same content (62% of the time). Further, Moore and Calvert (2000) found that those children who were presented information on the computer retained 33% more of the given information than those children in the teacher-directed lesson.

The purpose of the present research study was to measure the efficacy of the use of the TAP-i*t*® smart board and the online VizZle® program, to accelerate the progress on Individual Education Plan (IEP) goals and objectives of 8 children with autism (age three to five) in a public preschool program. Given the individual technologies' ability to adapt to individualized needs, the combined use provided a sound basis for reaching young children with autism spectrum disorders. The combination of these two technologies also made the study unique. The following five research questions guided this study:

1. How will eight students with autism between three and five years old respond to using TAP-i*t*®?
2. What aspects of TAP-i*t*® are helpful or effective for working with children with autism?
3. How will eight students with autism between three and five years old respond to using VizZle®?
4. What aspects of VizZle® are helpful or effective for working with children with autism?
5. Will the combined use of TAP-i*t*® and VizZle® improve acquisition of short-term learning objectives for a group of eight preschool children with autism?

Method

Procedure

The study took place in a preschool center. Consent for the research was obtained from the Director of the Exceptional Children's program. Notices and consent forms were sent home to the children's parents and guardians that described the study and requested permission for

their child's involvement. In order to optimize time allotted at the school, researchers used random selection to select eight participants from a group of twenty children who had parental consent. The TAP-i*t*® interactive white board with the VizZle® online software program downloaded on it was set up in a speech therapy room at the preschool. Due to availability of a small group of researchers and the intensive nature of the study only 8 children were selected.

Prior to the initiation of the study, a thorough review of each child's Individual Education Plan (IEP) was conducted. The review included the (1) assessment data and the current IEP and the (2) selection of one social and one academic goal as well as two objectives for each of the goal to use as a focus for individual lessons. Researchers conducted observations of the children in their classrooms and surveys were sent to classroom teachers and parents to elicit information about each child's strengths, needs, and interests. Data collection forms were created in order to collect progress on goals using percentage of accuracy and levels of assistance measures. Percentage of accuracy data were collected by the VizZle® program but the level of assistance was not included in the data collection system at the time of the study. The researchers felt that it was important to track both pieces of information.

Since the children in the self-contained classrooms used the picture exchange system (PECS), the researchers created transition cards in order to follow the same procedures. A picture card of the TAP-i*t*® was used to transition the children from the classroom and a picture of the child's teacher was used to transition them back to the classroom following the research session. The same procedure was also used with the one child who was in the inclusive to provide consistency across participants. The researchers coordinated classroom schedules for each of the five classrooms in order to have consistent times for the children to participate in the study. Participant times were scheduled during classroom center activity.

Figure 1: Transition Cards

A two-week trial (pilot study) was conducted prior to the major research study. The first week of the pilot study was used to familiarize the children with the TAP-i*t*® smart board and how to touch the screen to select items for the activities. Errorless learning activities were used during this period of time in order to assure success. Cameras were sent home to the parents and guardians in order capture the children's family members and favorite items. The pictures were then uploaded and inserted into online "All About Me" books using the VizZle® Magic Media tool and saved in each student's folder in VizZle®. The online program was introduced to the children during the second week of the pilot study and individual lessons were selected from the VizZle® library that were aligned with children's IEPs.

In preparation for the research study, an individual folder was created for each child and selected goals and objectives were placed in the individual folders in order to track progress. Individualized lessons were selected and saved in the folders. Data collection forms were developed to allow for the daily collection of qualitative information as well as the percentage of accuracy (number of trials) and levels of assistance needed for completion of the activities. (An example data collection sheet is located in Appendix A.) Because the level of assistance that a child needs to complete a task should decrease over time in order to show progress a numerical

system was used to designate the five specific levels of assistance used during this study; physical (5), modeled (4), verbal (3), nonverbal (2), and independent (1). Shown in Figure 2

Type of assistance	Description	Number
Physical	Physical guidance of child (hand-over-hand)	5
Modeled	Show the child how to complete the activity	4
Verbal	Describe how to complete the activity; step-by-step	3
Non-verbal	Use gestures or signs to indicate what to do during activity	2
Independent	Child completes activity without assistance	1

Figure 2: Levels of Assistance

Information from the pilot study was used to make changes to the data collection format and activities. The data collection forms were useful because the VizZle® program collected progress information in the form of percentage of accuracy but was unable to collect information about the level of assistance needed to complete the activities which was included on many of the IEP objectives. Activities and lessons were delivered and data were recorded by three research assistants and the primary researcher. Daily sessions (10) were recorded on video for use in inter-rater reliability checks.

Participants

Eight children who were between the ages of three to five and enrolled in a public school program for exceptional children participated in the study. Six participants were boys (75%) and two participants were girls (25%). Although unplanned, this combination reflects the typical occurrence of autism in relation to gender. The participants were diagnosed with developmental delays (2) and autism (6). Seven of the eight were enrolled in self-contained (SC) classrooms for children with autism while one participant was enrolled in an inclusive (I) classroom with typical

peers. Participants represented an overall developmental range from low to high. Although the participants were randomly selected from a pool they also represented 3 different cultural groups; African American, Caucasian, and Hispanic.

* Due to multiple absences during the research study, one child (participant 8) had limited data (one day) toward achievement of progress on achieving IEP goals and objectives. For this reason, he has been removed from this report of findings.

Participant	Gender	Age	Diagnosis	Developmental Level	Class
1	B	3	DD	High	SC
2	**B**	4	A	High	SC
3	G	4	DD	High	I
4	B	3	A	High	SC
5	B	4	A	High	SC
6	B	4	A	Low	SC
7	G	4	A	Low	SC
8	B	3	A	Low	SC

Figure 3: Participants

Description of Participants

A single-subject design was used because of the wide range of skills and the individual characteristics of the children who participated in this study. A description of each child and their individual goals and objectives are provided below. Individual interests and characteristics were addressed during the research sessions.

Participant 1, (Sunny*), was a three-year-old boy diagnosed with a developmental delay. He was highly motivated by trains, numbers, and letters and engaged in counting or spelling activities in the classroom. He also enjoyed music. He was always eager to participate in the computer activities.

Participant	Goals	Objectives

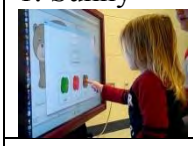
1. Sunny 	1. to increase overall learning skills to a developmentally appropriate (DAP) level with 80% accuracy(4/5 trials)	a. increase his ability to follow the lead of others by following directions
	2. to label common objects both receptively and expressively with 80% accuracy (4/5 trials)	a. point to objects when named b. identify objects when pointed to by an adult.

Figure 4: Participant 1 Goals and Objectives

Participant 2, (Tanner*), was a four-year-old boy diagnosed with autism. He was highly motivated by books that made noise as well as cause and effect toys. He was most engaged during counting or musical activities, and enjoyed books. He displayed both auditory and tactile sensitivity. Tanner enjoyed the bubble popping display reinforcement that followed selected lessons/activities. He displayed enjoyment after the reinforcement by hugging himself and smiling.

Participant	Goals	Objectives
2. Tanner 	1. to improve social skills to a DAP level through the completion of targeted tasks with 80% accuracy (4/5 trials)	a. take turns and share materials with decreasing levels of assistance
	2. to improve overall early learning skills to DAP level with 80% accuracy (4/5 trials)	a. count up to ten objects using one to one correspondence with 80% accuracy (4/5 trials) b. name basic colors (red, blue, yellow, green) when pointed to with 80% accuracy (4/5 trials).

Figure 5: Participant 2 Goals and Objectives

Participant 3, (Georgia*), was a four-year-old girl diagnosed with a developmental delay but had characteristics of autism. She was both outgoing and outspoken, and loved to engage in conversations. Georgia would become frustrated when she needed assistance in activities. She was highly motivated by music, movement, computer, music, reading, and painting.

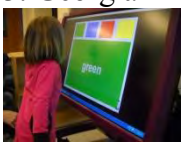
Participant	Goals	Objectives
3. Georgia 	1. improve her social skills to a DAP level through the completion of a targeted task with 80% accuracy (4/5 trials)	a. participate in turn taking activities with decreasing levels of assistance with 80% accuracy b. participation in joint attention in activities given verbal prompts when needed 80% of the time (4/5 trials)

Figure 6: Participant 3 Goals and Objectives

Participant 4, (Ethan*), was a three-year-old boy diagnosed with autism. He was challenged by changes in routine but generally adapted well. Ethan appeared to be very bright and enjoyed hands-on math and puzzle activities.

Participant	Goals	Objectives
4.Ethan 	1. independently identify shapes expressively and receptively with 80% accuracy(4/5 trials)	a. identify shapes (heart, oval, diamond, star, rectangle) by pointing to when named with 80% accuracy b. identify shapes (heart, oval, diamond, star, rectangle) by naming when pointed to with 80% accuracy
	2. independently identify common objects expressively and receptively with 80% accuracy (4/5 trials)	a. identify common objects (body parts, clothing, food) by pointing to when named with 90% accuracy given decreasing levels of prompts b. identify common objects (body parts, clothing, food) by naming with 90% accuracy given decreasing levels of assistance

Figure 7: Participant 4 Goals and Objectives

Participant 5, (Michael*), was a four-year-old boy diagnosed with autism. He was highly motivated by social praise and appeared to be timid and shy, but opened up to researchers once he established a relationship and routine. Michael preferred academic tasks. He displayed auditory hypersensitivity.

Participant	Goals	Objectives
5.Michael	1. independently identify concepts expressively and receptively with 80% accuracy (4/5 trials)	a. identify shapes (rectangle, oval, diamond, star, heart) by pointing to when named with 80% accuracy b. identify shapes (rectangle, oval,

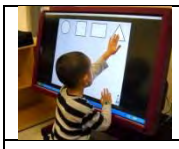
		diamond, star, heart) by naming when pointed to with 80% accuracy
	2. independently identify concepts expressively and receptively with 80% accuracy (4/5 trials)	a. identify common objects (body parts, clothing, food) by pointing to when named with 80% accuracy b. identify common objects (body parts, clothing, food) by naming with 80% accuracy given decreasing levels of prompts

Figure 8: Participant 5 Goals and Objectives

Participant 6, (Zack*), was a four-year-old boy diagnosed with autism. Zack displayed auditory sensitivity and motivated by tangible reinforcement that was not too loud or overly stimulating. Due to sensitivity he was easily aroused and had difficulty regaining focus once he became overstimulated. At the beginning the study Zach would roam about the room and needed repeated redirection back to the research activities. When it was time to return to the classroom he would run away from research assistants, lay on the floor, and stand on chairs amongst other avoidant behaviors. The behaviors subsided as he became familiar with the activities and routine. Zack thrived on individual attention, and was most engaged by focused tasks or activities when he was familiar with materials and routines.

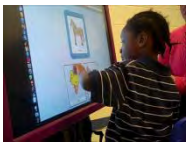
Participant	Goals	Objectives
6.Zack 	1. to increase communication skills to a developmentally appropriate level with 80% accuracy (4/5 trials)	a. identify objects or pictures by pointing to when named with 80% accuracy b. identify common objects (food, clothing, body parts) or pictures by naming with 80% accuracy
	2. to increase classroom competencies by improving his attending, organizational, and conceptual skills to a DAP level with 80% accuracy (4/5 trials)	a. pointing to and commenting on pictures when looking at an age-appropriate book b. attending to stories when read by an adult 4/5 trials

Figure 9: Participant 6 Goals and Objectives

Participant 7, (Jayden*), was a four-year-old girl diagnosed with autism. Jayden had

a difficult time adjusting to new activities and routines and avoided structured activities or interactions with peers in the classroom. When redirected or while waiting for a new lesson to appear on the screen, Jayden would cry, make noises, or hit the TAP-i*t*® screen. She was highly motivated by ongoing interactive games and activities. Jayden became so upset during breaks between activities that research assistants provided alternative activities, such as finger plays, to occupy her time.

Participant	Goals	Objectives
7.Jayden 	1. to increase competencies by improving attention, organizational, and conceptual skills to 80% (4/5 trials)	a.) touching pictures of herself, home, and family upon request with decreasing levels of assistance to independence with 80% accuracy b. attending to cause and effect toys or activities for one minute, three minutes, and until finished with minimal assistance to independence with 80% accuracy
	2. to demonstrate improvement in classroom skills and peer interaction to an age appropriate level	a. use words, gestures, or signs to make choices using decreasing levels of assistance b. increase social skills by interacting with an adult or peer at least one time in a fifteen minute period with 80% accuracy

Figure 10: Participant 7 Goals and Objectives

*Participant names have been changed in order to protect confidentiality.

Results

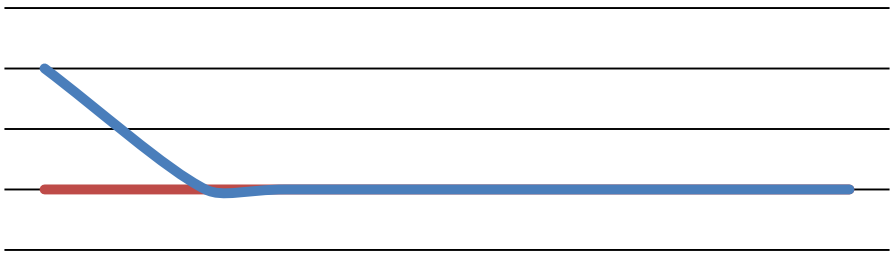
The results of the study indicate that all of the seven participants benefitted from the combined use of the VizZle® and TAP-i*t*® technologies and showed progress on the selected IEP goals and objectives. Six of the seven (86%) achieved all of their selected IEP goals and objectives and three of the seven participants (43%) exceeded the selected objectives and were advanced to higher learning activities. One participant made progress but did not fully achieve the selected IEP goals or objectives due to behavior difficulties at the beginning of the study.

Levels of assistance and accuracy were documented for all participants. Numbers were used to represent levels of assistance, as follows: 5 (physical), 4 (modeled), 3 (verbal), 2 (nonverbal), and 1 (independent). If more than one type of assistance was used, the highest level required for completion of a given activity was recorded. Data were compiled into one table, and grouped according to activity and then by IEP goal/objective.

Sunny

Sunny exceeded all of the selected IEP goals and objectives. The activity for Goal 1/Objective 1, identify objects both receptively and expressively, required Sunny to discriminate basic shapes which he achieved without intervention during the first session. A periodic check was completed to assure maintenance of the skill (no figure was created to represent this goal).

As shown below (see Figure 11), Sunny was able to complete Goal 2/Objective 1(point to objects when named) with 100% accuracy. He initially required verbal assistance.. Over four additional trials, he maintained his accuracy and maintained a level of independence. Sunny was able to exceed his IEP Goal 2/Objective 2 (identify objects when pointed to) through the activity "Brown Bear, Brown Bear book", during which he independently verbally identified objects and colors with 100% accuracy.

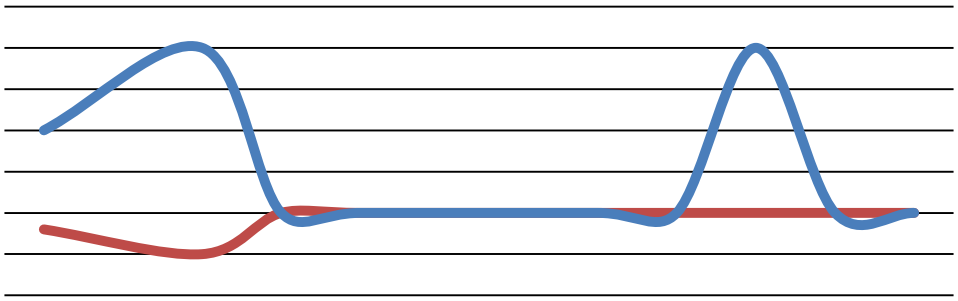


	1/24/16	1/26/16	1/27/16	2/2/16	2/3/16
% Accuracy	100%	100%	100%	100%	100%
Level of Prompt	3	1	1	1	1

Figure 11. Sunny's graph for matching objects to color (receptive). This activity addresses Goal 2/Objective 1,point to objects when named.

Tanner

Tanner exceeded all of his indicated IEP goals and objectives through the combined use of VizZle® and TAP-It®. As shown below (see Figure 12), Tanner progressed from 80% to 100% accuracy over nine trials in an activity that addressed Goal 1/Objective 1(turn taking). Tanner fluctuated between nonverbal and verbal assistance for three of the nine trials, but achieved independence by the last two days of the study. In another activity based upon Goal 2/Objective 1 (discriminating common objects), Tanner progressed during three trials from 0% to 100% accuracy, and from verbal assistance to independence. Thus, Tanner achieved the objective. Lastly, Tanner achieved his Goal 2/Objective 2 (name basic colors) using the "Brown Bear, Brown Bear book" activity. He maintained 90% or 100% accuracy during the three days this activity was used and progressed from verbal assistance to independence thus meeting the IEP goal and objective.



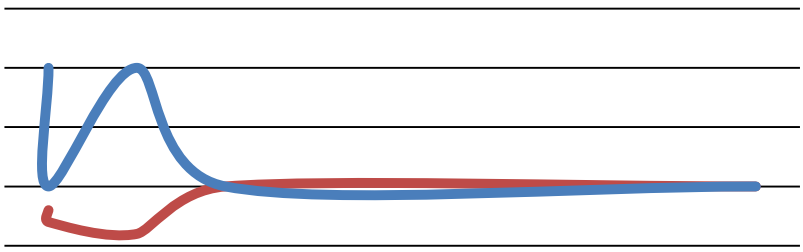
	1/24/16	1/26/16	1/27/16	1/28/16	1/31/16	2/1/16	2/2/16	2/3/16	2/4/16
% Accuracy	80%	50%	100%	100%	100%	100%	100%	100%	100%
Level of Prompt	2	3	1	1	1	1	3	1	1

Figure 12. Tanner's graph for color game activity. This activity addresses Goal 1/Objective 1, taking turns and following directions.

Georgia

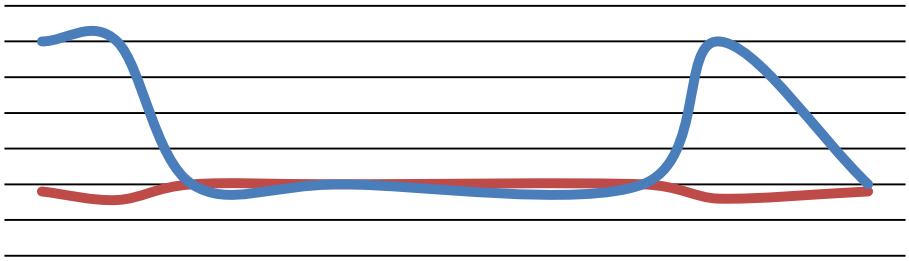
Georgia exceeded all of the selected IEP goals and objectives through the combined use of VizZle® and TAP-i*t*®. As shown below (see Figure 13), Georgia improved in her social skills to a DAP level through the use of a math game on the VizZle® program. The game facilitated

social skills by encouraging turn taking, appropriate responses to winning and losing, and full engagement in the game. Further, Georgia progressed from needing verbal assistance to remember game oriented social skills to taking part in the game correctly and independently. Georgia was also able to address her Goal 1/Objective 2 through matching sets to numbers activity. As shown below (see Figure 14), Georgia initially required verbal assistance to participate in the joint attention activity with 80% or above accuracy; however, by the end of the study Georgia was able to complete the activity independently.



	1/24/16	1/24/16	1/25/16	1/26/16	2/1/16
% Accuracy	60%	40%	20%	100%	100%
Level of Prompt	3	1	3	1	1

Figure 13. Georgia's graph the math game activity- improving social skills to DAP level. This activity addresses Goal 1/Objective 1.



	1/24/16	1/25/16	1/26/16	1/28/16	2/1/16	2/2/16	2/4/16
% Accuracy	90%	78%	100%	100%	100%	80%	90%
Level of Prompt	3	3	1	1	1	3	1

Figure 14. Georgia's graph for matching sets to numbers. This activity addresses Goal 1/Objective 2, participation in joint attention activities.

Ethan

Ethan achieved all of his selected IEP goals and objectives through the combined use of VizZle® and TAP-i*t*®. As shown below (see Figure 15), Ethan expressively (name when pointed

to) matched sets to objects with 100% accuracy across two trials and progressed from verbal assistance to independence. He was also receptively (point to when named) matched sets to objects with 100% accuracy and complete independence. Therefore, he successfully achieved Goal 2/Objectives 1 and 2. In another activity, discriminating basic shapes, Ethan was able to address and achieve Goal 1/Objectives 1 and 2 (see Figure 16). Ethan was required to receptively match shapes (given two choices) and expressively identify the shapes as he matched them. Ethan progressed from verbal assistance to independence, and increased in his accuracy from 40% to 100%.

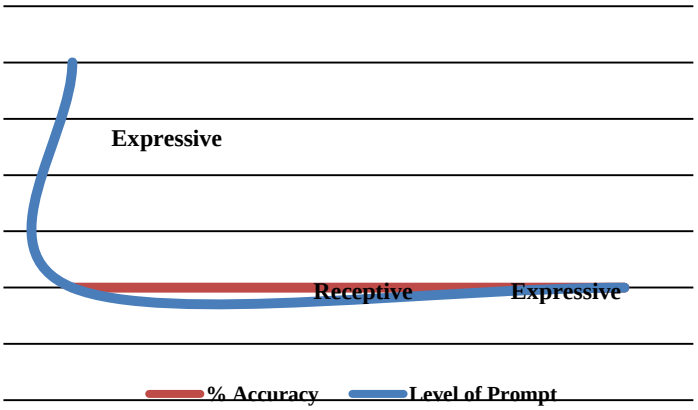
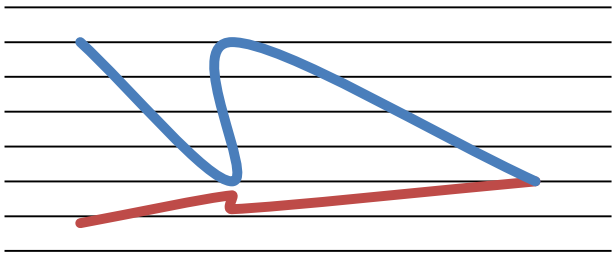


Figure 15. Ethan's graph for matching sets to objects (expressive and receptive). This activity addresses Goal 2/Objectives 1 and 2, point to when named and naming objects.

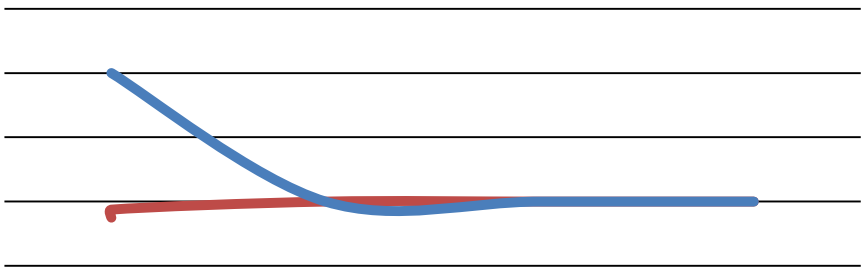


	1/24/16	1/25/16	1/25/16	1/27/16
% Accuracy	40%	80%	60%	100%
Level of Prompt	3	1	3	1

Figure 16. Ethan's graph for identification of basic shapes. This activity addresses Goal 1/Objectives 1 and 2 identifying shapes by pointing to and naming.

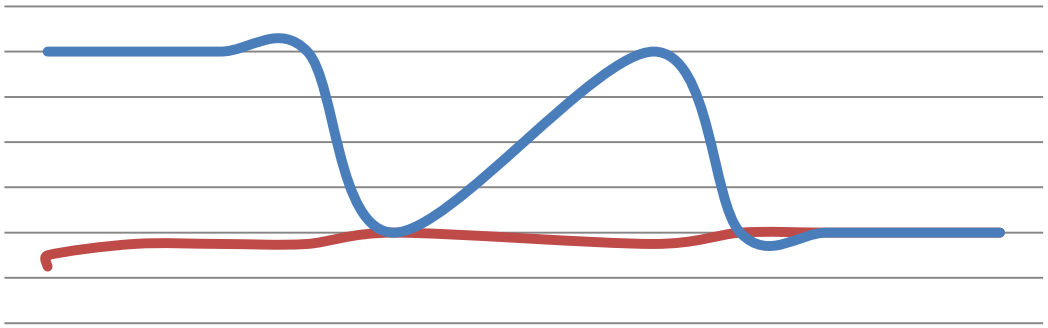
Michael

Michael achieved all of his indicated IEP goals and objectives through the combined use of VizZle® and TAP-i*t*®. As shown below (see Figures 17 and 18), Michael achieved Goal 2/Objectives 1 and 2 with an activity focused on body part recognition. Michael identified the body parts expressively with 60% accuracy initially and progressed to 100% accuracy by the end of the study. He decreased in levels of assistance needed from verbal assistance to independence. Michael also matched body parts receptively with 75% accuracy initially to 100% accuracy by the end of the study. In this activity, he also decreased in levels of assistance needed from verbal to independence. In another activity, shape identification, Michael independently and with 100% accuracy matched shapes receptively. In the same activity, Michael was also asked to complete the identification task expressively. He did so with 87.5% accuracy initially and progressed to 100% accuracy by the end of the study. Further, he progressed from the need for verbal assistance to independently identifying shapes by the end of the study. Therefore, he was able to achieve Goal 1/Objectives 1 and 2.



	1/24/16	1/24/16	1/25/16	1/26/16	1/27/16
% Accuracy	75%	88%	100%	100%	100%
Level of Prompt	3	3	1	1	1

Figure 17. Michael's graph for recognizing body parts (receptive). This activity addresses Goal 2/Objective 1, identify common objects by pointing to when named.

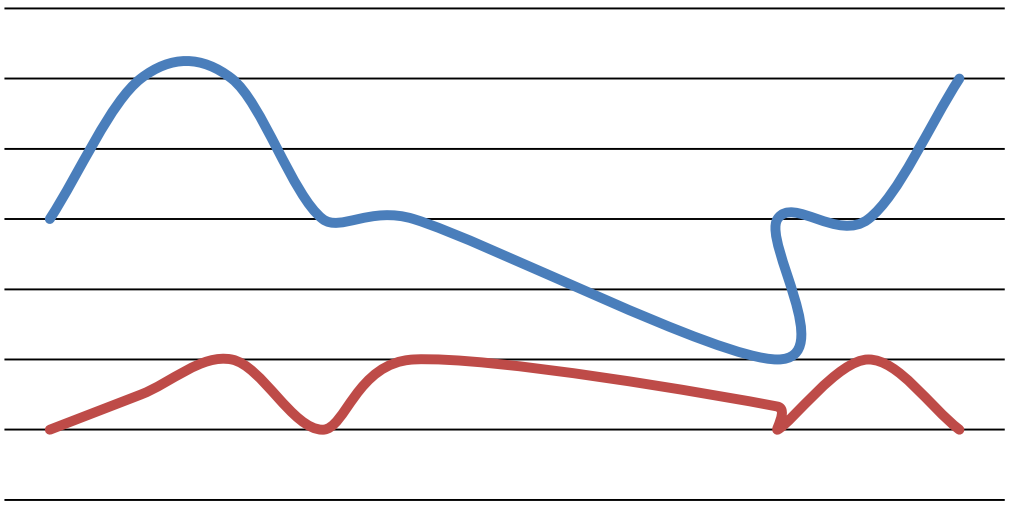


	1/23/12	1/23/12	1/24/12	1/25/12	1/26/12	1/27/12	1/30/12	1/31/12	2/1/12	2/2/12	2/3/12
% Accuracy	63%	75%	88%	88%	88%	100%	88%	100%	100%	100%	100%
Level of Prompt	3	3	3	3	3	1	3	1	1	1	1

Figure 18. Michaels's graph for recognizing body parts (expressive). This activity addresses Goal 2/Objective 2, identify common objects by naming.

Zack

Challenging behaviors and a short attention span inhibited Zack's progress during this study. Zack had good and difficult days. He required less assistance to achieve higher accuracy with some activities, and with others needed a combination of assistance in order to help him succeed. Zack did make some progress toward his goals/objectives, but due to the inconsistency in his responses, he did not achieve any of his IEP goals or objectives. However, upon review of the data, one might notice that Zack appeared to benefit from a combination of assistance, as he was able to complete activities with more accuracy when the researchers gave either physical assistance alone or in combination with verbal (see Figure 19). This is an important result as it helps to explain Zack's success in some situations, and it can help shape future interactions with Zack. When prompted by the researcher and subsequently reinforced by the researcher or interactional visual stimuli on the screen, Zack was more likely to complete the task with accuracy and with greater engagement.



	1/24/16	1/25/16	1/26/16	1/27/16	1/28/16	2/1/16	2/1/16	2/2/16	2/3/16
% Accuracy	0%	50%	100%	0%	100%	33%	0%	100%	0%
Level of Prompt	3	5	5	3	3	1	3	3	5

Figure 19. Zack's graph for "All About Me" book- improving classroom competencies to DAP level. This activity addresses Goal 2/Objective 1, pointing to and commenting on pictures.

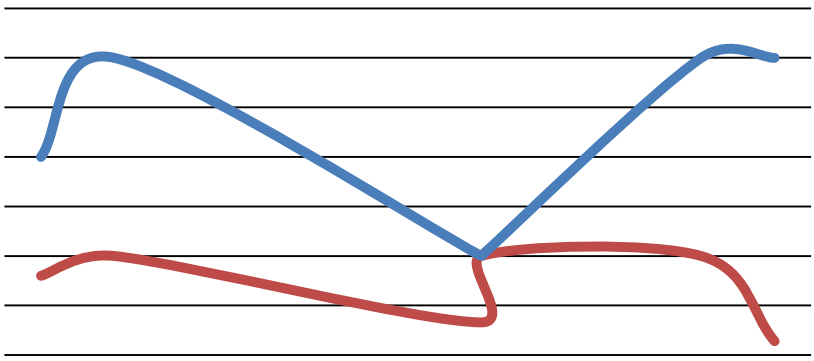
Jayden

Jayden achieved all of her IEP goals and objectives through the combined use of VizZle® and TAP-i*t*®. In an activity where Jayden was challenged to discriminate farm animals using words and gestures to indicate choice, Jayden completed the activity independently with 100% accuracy, thus achieving Goal 2/Objective 1. Jayden achieved Goal 2/Objective 2 by playing a color game with her peer coach (Figure 20), Georgia. Jayden remained engaged throughout the game and took turns appropriately. Jayden's accuracy increased, ability to perform independently increased, and time on task increased upon exposure to a peer coach from January 30-February 2 (See Figures 21 and 22). When Georgia was present, Jayden required less assistance from the researchers to complete tasks, and was able to stay on task.

Figure 20. Peer coaching

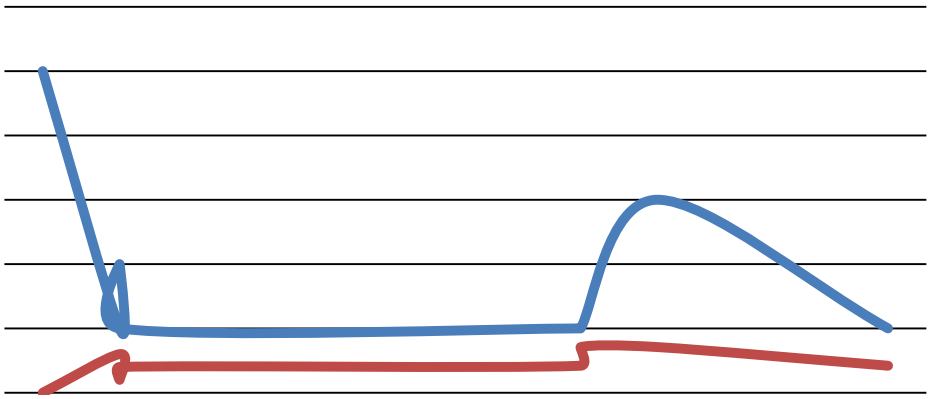
Jayden also achieved Goal 1/Objectives 1 and 2 though her interaction with the "All About Me" book. Jayden initially had a difficult time with attention during the activity possibly because it was not interactive like the other activities. However, upon more exposure to her book and with her peer coach present, Jayden progressed from attending to the story with verbal assistance for less than a minute to independently attending to the story until finished. Further, Jayden progressed from lack of interaction with the book to independently pointing to herself in pictures of as well as those of the home, family, and other objects.

Jayden, like Zack, presented challenging behaviors, which included crying, not wanting to sit in one place, getting up frequently, and beginning activities before taking the time to understand the tasks. However, these challenging behaviors significantly diminished when Georgia was present. The last day of the trial Jayden presented with the same challenging behaviors when Georgia was not present. The impact of Georgia's presence on Jayden's success is noteworthy, and Jayden's decline without Georgia present on the last day is also noteworthy (See Figures 21 and 22). Without Georgia's presence during Jayden's timeslot, it is unclear if Jayden would have achieved any of her IEP goals and objectives, let alone all of them.



	1/25/16	1/26/16	1/31/16	1/31/16	2/3/16	2/4/16
% Accuracy	80%	100%	33%	100%	100%	14%
Level of Prompt	2	3	1	1	3	3

Figure 21. Jayden's graph for naming farm animals (expressive and receptive). This activity addresses Goal 2/Objective 1, pointing to pictures on request.



	1/24/16	1/25/16	1/25/16	1/25/16	1/31/16	1/31/16	2/1/16	2/4/16
% Accuracy	0%	60%	20%	40%	42%	71%	71%	42%
Level of Prompt	5	1	2	1	1	1	3	1

Figure 22. Jayden's graph for color matching. This activity addresses Goal 1/Objective 2, attending to activities.

Discussion

In conclusion, this study demonstrates the effectiveness of using selected assistive technologies with preschool-aged children who have autism. All of the seven participants made progress, six of the seven (86%) participants were able to achieve all, and three of the seven exceeded their selected goals and objectives. The individualized VizZle® lesson plans allowed the researchers to individualize lessons based on achievement throughout the study. Due to

excessive absenteeism one participant was unable to participate in the research activities and thus progress data were not generated. Challenging behaviors interfered with one participants' progress during the study. After the behavior was addressed progress was made but goals were not achieved.

A few helpful aspects of TAP-i*t*® include its mobility and recognition of intentional versus accidental touch. Since the board can adjust to accommodate a range of heights and directions as needed, TAP-i*t*® is helpful for those who are working with children who enjoy leaning on surfaces and being close to electronic screens. Further, its' ability to recognize only intentional touch was crucial while working with children who supported themselves by touching the screen while interacting with the VizZle® technology and choosing answers for activities.

All of the children in the study responded well to TAP-i*t*® and enjoyed interacting with the technology. They were intrigued by the large monitor that was part of the smart board which provided large images that were easy to see. While it took a few trials for the children to understand the intentional touch aspect of the TAP-i*t*®, they easily became accustomed to tapping the monitor to make selections during learning activities. The adjustability feature (raising or lowering the monitor) of the smart board also made it easy for the researchers to accommodate each child's specific needs.

The VizZle® software program provided opportunities to engage in activities that were aligned to their developmental level as well as the individual education plan. The children engaged in a variety of activities (matching, recognition, etc.) that were provided through different means (interactive matching boards, games, etc.). All sessions began with an errorless activity to reacquaint the children with the assistive technology program. The program also had a variety of built-in reinforcement that followed the completion of activities. A favorite

reinforcement involved a fireworks simulation on the screen which required that the children move their hand across the screen to change the colors of the fireworks. All of the children were highly stimulated by the display and change in colors, and were excited to see how their interaction with the board created the change. Another favorite was the popping of balloons.

Overall, all of the seven participants improved acquisition of short-term learning objectives as demonstrated by gains in IEP goals and objectives through the combined use of the two specific assistive technologies. While the technologies are still fairly new, they merit great regard given the strides of the students in this study. As the need for specialized intervention and support grows for this unique population, the combined use of VizZle® and TAP-i*t*® demonstrate an effective approach to assisting children in achieving IEP goals and objectives.

While the majority of the participants' IEPs did not require them to complete goals and objectives independently, it was helpful for the researchers to record this data in order to make sense of the participants' progress from the beginning to the end of the study. Had this data not been recorded, it would be difficult to see how these participants benefited from the combined use of the assistive technologies and interpretation of results. Further, it punctuates the importance of documenting levels of assistance for all children when working on IEP goals and objectives. Knowledge of the level of assistance needed to complete a task is critical to the child's success, and consequently shapes adult to child interaction. A child's success is often dependent on the assistance provided by others however it is important to gradually "fade" the level of assistance so the child can achieve success with greater independence. It is important to note that much of the participants' progress was in the realm of levels of assistance. Tracking decreasing levels of assistance allows for better clarification of the progression that occurred

during the study, and how the combined use of VizZle® and TAP-i*t*® helped them to achieve their IEP goals and objectives.

Limitations

There were several challenges that the researchers faced during the initiation of the study. These challenges included; incorporating the PECS® system, teaching children how to use the TAP-It!® interactive white board, development of individualized data collection sheets, recording data, writing log notes, selection of individual activities, and addressing challenging behaviors.

The researchers experienced difficulty when an activity or lesson was copied and put into another child's online folder because the lesson number would change. Thus, when the researchers searched for the activity by the original lesson number, they were often unable to find the lesson. This caused the participant to wait and become distracted. Consistency in lesson numbering is essential to the tracking of progress; thus, the researchers had to continually edit lesson numbers on data collection sheets and later on the collected data table to make sure they were consistent. This challenge has been communicated to VizZle®.

In addition, in order to use the TAP-i*t* ® during the research study a laptop computer had to be connected to back of the interactive white board in order to access the online VizZle® program. This required one research assistant to be positioned at the laptop in order to change activities for the child. Therefore two researchers were required at every session with a child; one to change and one to facilitate activities.

The greatest challenges that the researchers were unable to control were participant absence due to illness or other factors and the varying class schedules. The research team was limited to data collection between the hours of 9 am to 11:30 am and a two week time span.

Therefore, if any participant was absent, late, or needed to leave school early, the overall results of the study were impacted, because that participant did not have the same amount of data collected toward their progress on IEP goals and objectives. This is precisely the challenge that was presented with participant eight. Due to many school absences over the course of the study and limited data collected, it is difficult to draw definite conclusions as to the effectiveness of the combined use of technology with regard to his IEP goals and objectives.

The study also took place in the same room in which the speech therapist worked with children. This was the location that was assigned to the researchers for use during the study. While there was a wall separating the areas of the room, the researchers and participants could overhear the therapy and some participants were especially distracted by what was occurring on the other side of the wall, particularly Zack and Jayden. Once the participant was distracted, he or she would run to the other side of the wall, become less engaged with the technology, and decrease time on task. For those children who were highly distractible, this negatively influenced individual participant results.

Finally, the length of time between participants was a notable limitation of the study. Due to the tight schedule and limited hours available at the school, the researchers did not have time to debrief after each participant session. Further, the researchers were unable to process the successes or challenges and create group notes for each participant following their timeslot. More time between participants would have optimized the overall study by helping the researchers to realize participant potential sooner and adjusting the intensity of his/her activities accordingly.

Areas for Future Research

An important outcome of the study was the recognition of the value of *peer coaching* for enhancing progress of social goals for children with autism. Due to an error in timing, two of the participants arrived for their sessions at the same time, and the researchers decided to let the participants complete activities together. During activities which emphasized math and color games, one participant, Georgia, was able to address her IEP goal of improving social skills, while the other participant, Jayden, was able to address her IEP goal of increasing peer interaction to an age appropriate level. The two participated in turn-taking activities, and Georgia served as a social coach to Jayden. This *incidental experience* led the researchers to question the unrecognized value of peer coaching in combination with the use of assistive technology.

Another area for further research is a comparison of the use of assistive technology input methods. The growing popularity of the use of assistive technology with children with special needs makes it important to understand specific features of different devices and programs as well as what is most effective to use with this population. While the unique features of VizZle® and TAP-i*t* ® have been highlighted in this article, future research should focus on a comparison of assistive technology programs and devices, as well as input methods.

Finally, the expansion of the study to involve a larger sample of children across different age levels would provide valuable information to support the findings. In addition, the use of the VizZle® program with other types of technology such as the touch screened computer, a smart board, as well as the iPad ® would provide additional information about the ease of use with a wider range of available technology devices.

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