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# Efficacy of *TeachTown: Basics* computer-assisted intervention for the Intensive Comprehensive Autism Program in Los Angeles Unified School District

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Computer Assisted Instruction (CAI) has shown increased popularity recently and there are many studies showing promise for this approach for children with Autism Spectrum Disorders (ASD). However, there are no between-subject studies to date assessing the efficacy of CAI with this population. In this study, 47 preschool and K-1 students in ASD classrooms participated from Los Angeles Unified School District. *TeachTown: Basics*, a CAI program which also includes supplementary off-computer activities, was implemented over 3 months for approximately 20 minutes per day on the computer and 20 minutes per day in supplementary *TeachTown: Basics* activities. Compared to the students in the control group, the *TeachTown: Basics* students showed more improvement overall on language and cognitive outcome measures. In addition, students who used *TeachTown: Basics* demonstrated significant progress overall in the software and those students who used the program for more time demonstrated larger gains within the software and in outcome measures. Although not conclusive, these findings offer possibilities for the use of CAI for remediating many deficits for children with ASD and other special needs. In addition, CAI may offer solutions

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to schools and parents with insufficient funds for more expensive treatments.

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The number of special education students exceeds the resources available in schools to educate these children (McLeskey, 2004). There are 6.7 million students between ages 3 and 21 served by IDEA (The Individuals with Disabilities Act) in the United States. The education of students with an Autism Spectrum Disorder (ASD), now one of the most common childhood disorders, is particularly problematic as prevalence rates are much higher than previously assumed (Huebner, 2001).

In addition to the increasing numbers of children identified needing services in special education, decreasing resources, staff, and training are difficult issues for cash-strapped schools (Ganz, 2006). Schools are actively seeking low cost alternatives to help them cater to the many needs of these students without exceeding their budgets. In the public school setting, effective programs such as Applied Behavior Analysis (ABA) are challenging to implement with fidelity and challenging to fund. There are commonly used interventions such as video modeling (Charlop-Christy et al., 2000) or the TEACCH (Treatment and Education of Autistic and related Communication-handicapped CHildren) model (Mesibov, 1997) that have been shown to be effective and are inexpensive, but are often time-consuming to implement, require substantial time to prepare materials, and data collection and progress monitoring can be an issue for over-burdened teachers.

Special education students, especially children with ASD, tend not to respond well to traditional teaching strategies (Schreibman, 1988) and more and more teachers are choosing alternative treatment choices for their classrooms to accommodate these children (e.g., Schilling and Schwartz, 2004). Many students with ASD have been shown to respond well to treatments that involve visual supports. These visual support systems include videos (e.g., Charlop-Christy et al., 2000; Schreibman et al., 2000), pictures (e.g., Bryan and Gast, 2000), and computers (e.g., Bernard-Opitz et al., 2001; Hetzroni and Tannous, 2004). Video modeling (videotape of a model demonstrating desired target behavior) and video priming techniques (video of upcoming events or environments minus a model) have been successful in teaching a variety of play skills (D'Ateno et al., 2003) and social behaviors (Nikopoulous and Keenan, 2004) as well as decreasing problem behaviors during community transitions (Schreibman et al., 2000). Programs that emphasize visual support strategies are commonly used in special education classrooms. For instance, the TEACCH program utilizes visual cues to increase independence and to teach new skills to children. Curricula for children on the spectrum tend to emphasize visual supports and repetition in teaching activities (e.g., McAfee, 2002). Another example is the PECS (Picture Exchange Communication System) program, which uses visual supports to facilitate communication (e.g., Bondy and Frost, 1994; Charlop-Christy et al., 2002).

As children with ASD tend to respond well to things that interest them (Koegel and Mentis, 1985), and because children with ASD often respond well to treatments that use visual supports (e.g., Dettmer et al., 2000), computers are a logical choice for intervention. Many studies show that computer assisted instruction (CAI) can provide an efficient and effective learning environment that is more motivating (Keller and Suzuki, 1988; Kinzie, 1990; Malone, 1982; Padma and Ross, 1987; Traynor, 2003) than traditional instruction for many students, particularly students with ASD. Several studies have demonstrated that children with ASD may learn more rapidly with a computer than with traditional teaching strategies. Bosseler and Massaro (2003) developed and assessed a computer-animated tutor to teach vocabulary and grammar to eight children with ASD. Their program included receptive and expressive language activities. This program was successful in teaching language to all participants and generalization to the children's natural environment was reported. Computerized techniques were utilized to teach social understanding to children with ASD via computerized social stories (Bernard-Opitz et al., 2001). Children with ASD did better with computerized visual social stories than without. In another computer-based intervention (Hetzroni and Tannous, 2004), children with ASD were taught communicative functions using a specially designed software program that targeted form, use, and content of language. Children learned the material more efficiently on the computer than off and demonstrated a transfer of these skills to the natural classroom environment. CAI effectiveness is not novel, as several papers have demonstrated. The extensive research offers promise for the use of CAI for children with ASD, but more research is needed on the efficacy of particular programs.

*TeachTown: Basics* is a CAI program that also includes off-computer Connection Activities, automatic data collection and reporting, and a note system for communication with the child's team. Initial research supports treatment efficacy in using the *TeachTown: Basics* program. In a previous study, eight children (four with ASD and four with other developmental disabilities) participated with their parents in a two-month treatment program using *TeachTown: Basics* (Whalen et al., 2006). There was a significant change (53% increase) from pre-test scores to post-test scores using the CAI program. There were collateral effects that were also observed. Children with ASD demonstrated a 105 percent increase in language and social behaviors while working on *TeachTown: Basics*. Specifically, the children used more spontaneous comments (e.g., "Look Mom, a rocket ship?"). Whereas appropriate language increased, inappropriate language and behaviors decreased by 61 percent. Children also looked at their parents more and showed more enjoyment (i.e., demonstrated positive affect) while working on the computer. And whereas positive social behaviors increased, inappropriate behaviors such as tantrums and avoidance decreased. In addition, inappropriate behaviors and inappropriate language also decreased by 44 percent during the off-computer activities compared to baseline play sessions.

Although this study was promising, it is important to assess the usefulness of the program in a school setting, where CAI programs for students with special needs are in short supply. In this study, the effectiveness of *TeachTown: Basics* was assessed in a randomized (by classroom) trial implemented in a special education program for young students with ASD. It was hypothesized that the students using the *TeachTown: Basics* program would show more improvement in language, cognitive, auditory processing, and social skills than similar students in the control group.

## Method

### Participants and design

The participants were all students, ages 3 to 6 years, with an eligibility of autism who attended Los Angeles Unified School District's Intensive Comprehensive Autism Program (ICAP). Eight classrooms were randomly assigned to a Control Group or to a *TeachTown: Basics* Treatment group. All students in each classroom were invited to participate but only those with parental consent were allowed to be in the study. A total of 47 students participated in the study. Twenty-two students comprised the treatment group and attended one of four classes (two preschool and two kindergarten/first grade classes) at two elementary schools. An additional 25 students comprised the control group and attended one of four classes at two different elementary schools, for a total of eight classes in four schools. The level of autism for each student was determined based on the Childhood Autism Rating Scale (CARS; Schopler et al., 1986), administered by each student's teacher. Overall, both groups presented as students with severe autism. Table 1 summarizes the distribution of students in the treatment group and control group based on grade/classroom, number of participants, and CARS results.

A between subject, randomized (by classroom) design was implemented. Students were randomly assigned by classrooms rather than individually

***Table 1*** **Participant characteristics at intake**

| *Classroom* | *Grade(s)*[a] | N | *CARS score* M[b] |
|---|---|---|---|
| Treatment #1 | Preschool: 8 students | 6 | 33 |
| Treatment #2 | K-1: 5 students | 5 | 39 |
| Treatment #3 | Preschool: 8 students | 5 | 44 |
| Treatment #4 | K-1: 8 students | 6 | 52 |
| | | Total: 22 | Avg: 42 |
| Control #1 | Preschool: 8 students | 7 | 45 |
| Control #2 | K-1: 7 students | 5 | 37 |
| Control #3 | Preschool: 7 students | 6 | 45 |
| Control #4 | K-1: 7 students | 7 | 45 |
| | | Total: 25 | Avg: 43 |

a. Grade of students and total number of students in each class.
b. Range of autism severity on the CARS (Childhood Autism Rating Scale): 15–29 = non-autistic, 30–36 = mildly-moderately autistic, 37–60 = severely autistic.

due to teacher training and feasibility of data collection and consistent implementation, as well as due to ethical concerns regarding offering an intervention to one student in the class and not another.

## Materials and intervention

The intervention used was *TeachTown: Basics*, a CAI program that includes computer lessons and natural environment activities (Connection Activities) for developmental ages 2–7 years. The computer lessons offer a focused learning environment where the child works on the computer and completes lessons that incorporate the basic principles of ABA. The student is taught in a discrete trial format where they receive reinforcement for correct responses in the form of 15 to 45 second animated reward games delivered on a Variable Ratio 3 schedule. Correct responses are also immediately reinforced with verbal praise and graphics. The computer lessons use a discrete trial format using a within-stimulus prompting procedure (distracters literally fade in and out to help the child succeed with the lesson. A verbal instruction is given by the program and the student clicks on the correct response from a field of 3 to 8 choices. Multiple exemplars are used for each concept taught and mass trialing is not used in order to facilitate generalization. Instead, at least two different concepts (e.g., dog and cat) are taught in the same set of trials and the instructions vary slightly from trial to trial so that the child must listen to the instructions for every trial. In addition, a large variety of images are used (photos, clipart, drawings) to facilitate generalization. Maintenance trials are interspersed with training trials.

The program progresses each student through the curriculum at their own pace. Initially, the teacher takes a rank placement questionnaire to place each student in the computer curriculum. For each lesson, a student is given a pre-test. If the student correctly responds to 80 percent or more of trials, the pre-test is passed and the student progresses to the next lesson. If the student scores less than 80 percent correct on the pre-test, training exercises ensue. When the student scores 80 percent or greater correct on training exercises with no prompting, a post-test is given. If the student passes the post-test (the criterion is still 80%), he or she progresses to the next lesson. If the student fails the post-test, the process repeats. Stimuli in tests are different than stimuli in training exercises to facilitate generalization of concepts rather than memorization of specific target stimuli. Because the curriculum is individualized to each student's needs, students in the treatment group participated in a variety of lessons with the *TeachTown* curriculum. The dependent variables included concepts from the four learning domains (Receptive Language, Social Understanding, Life Skills, and Academic/Cognitive Skills). (Refer to the Appendix for a sample of lessons in the *TeachTown* curriculum.) Teachers were asked to have the child complete 20 minutes per day on the software.

*TeachTown Connection* off-computer activities are lesson plans to implement in the natural environment for the student to work on skills that are not targeted on the computer (e.g., expressive language, play, imitation, social interaction, motor skills, and daily living skills) and to enhance generalization of skills learned on the computer to the natural environment. These activities were designed to follow developmental models in their structure and use the principles of Pivotal Response Training (PRT).

An automated data collection tracking and reporting system assesses child progress as they move through the computer curriculum. This allows school staff to assess the effectiveness of the intervention and to determine which skills may need more targeted work in the natural environment through the off-computer activities. This reporting system makes it easier for teachers, parents, and service providers to more frequently and effectively assess student progress and make data-based decisions for lesson planning. In addition, reports are available for school administrators to assess student, teacher, and parent usage of the program, to evaluate how well the program is working overall and to quickly and easily establish who is using the program regularly and who is not.

A communication system is provided within the software for school staff, parents, and various educational team members to document anecdotal reports, daily information about the child's performance, or any other relevant information to the child's success with the program in order to ensure the entire team is communicating effectively.

Internet synchronization and updating of data allows the teacher to share information with the families and other educational team members and for the child to be able to use the program at home and in numerous additional learning environments (e.g., the speech language pathologist's clinic, daycare, home, et cetera).

## Setting

This research was conducted in preschool and K-1 Intensive Comprehensive Autism Programs (ICAP) within the Los Angeles Unified School District. The ICAP is a special day class program for students with an eligibility of ASD on general education elementary campuses that operates 27 hours per week for the preschoolers and 30 hours per week for the K-1 students. The ratio of adults to students is 1:2, with no more than eight students in the class. Language/communication, sensory, and behavioral needs are all addressed within the context of the program. Related service providers for speech and language and occupational therapy deliver additional, direct intervention within the classroom setting. The physical structure of the classroom is based on TEACCH principles, whereas the direct teaching of lessons utilizes an ABA approach, typically discrete trials. When participants were not doing the *TeachTown: Basics* program, they participated in the above setting as their regular school day. The control group only received regular school day instruction; no additional interventions were used.

## Procedure

All participating students were assessed at the beginning of the school year to measure autism severity and establish baseline skills (Pre-Treatment), and were re-assessed on all measures except the CARS at the school year mid-point. Students in the control group continued with their regular educational program until the school year mid-point.

Teachers in the *TeachTown: Basics* group participated in a 2-hour training session from the principal investigator on how to implement the program and how to set up the classrooms for optimal implementation.

Students in the *TeachTown: Basics* group received daily computer sessions for approximately 20 minutes each (either two 10-minute sessions or one 20-minute session) and participated in a 20-minute off-computer activity from the *TeachTown: Basics* program in either a 1:1, small group, or full class activity (e.g., circle time). To accommodate *TeachTown: Basics* into the regular school day, teachers were required to replace *TeachTown: Basics* with other activities so in most cases, the child's regularly scheduled 1:1 direct teaching time was replaced with *TeachTown: Basics* computer time. In this study, teachers were asked to implement Connection Activities in 1:1, small group, or circle time instruction for 20 minutes per day. Teachers were unable to collect data on Connection Activities due to limited time and resources in the classroom. Although they were asked to implement and anecdotally reported regular usage of these activities, it is difficult to assess the fidelity of implementation for this part of the intervention.

## Measurement

The following assessments were administered at Pre-Treatment:

(1) Peabody Picture Vocabulary Test, 3rd Edition (PPVT-III; Dunn and Dunn, 1997). The PPVT is a measure of receptive language abilities. This measure was administered and scored by a district Autism Specialist. Reliability for the PPVT-III has internal consistency with alpha .92 to .98 (median: .95) and split-half .86 to .97 (median: .94); alternate-form reliability is .88 to .96 (median: .94) and test-retest reliability is .91 to .94 (median: .92).

(2) Expressive Vocabulary Test (EVT; Williams, 1997). This measure is co-normed with the PPVT-III and is a quick and easy assessment for tracking progress in expressive vocabulary. The EVT reliability analyses indicate a high degree of internal consistency. Split-half reliabilities range from .83 to .97 with a median of .91. Alphas range from .90 to .98 with a median of .95. Test–retest studies with four separate age samples resulted in reliability coefficients ranging from .77 to .90, indicating a strong degree of test score stability.

(3) The Brigance Inventory of Early Development (Brigance, 2004). The Brigance provides a measure of the child's skills, along with suggestions for next steps for the child's learning program. The Brigance is a series of criterion-referenced assessments that help educators determine students' developmental and performance levels in a wide range of skill areas. The teachers in LAUSD regularly administer the assessment. For the purposes of this study, the following areas were assessed: Receptive Language, Expressive Language, Body Image (i.e., body parts), Social Skills, Auditory Processing, General Concepts, and Matching.

(4) Childhood Autism Rating Scale (CARS; Schopler et al., 1986). The CARS is an autism checklist that is based on an observation of the child in a structured setting. The rater scores the child's behavior on a scale ranging from 'normal' to 'severely abnormal' for each of 15 subscales. This form was completed by each child's classroom teacher.

(5) Ongoing Automatic Data Collection (*TeachTown: Basics*). The *TeachTown: Basics* software program collects on-going data on each child during the treatment phase in order to assess short-term progress and individual differences in progress. The software is designed to collect data for every trial and has an automated data tracking system. This allows the research

team to be able to look at treatment data following each child's session and allows the teacher to regularly look at the data to make data-based decisions for off-computer lesson planning. Student progress data was not collected during implementation of the off-computer lessons.

With the exception of the CARS, all of the above measures were used again in the spring with all students (i.e., post-treatment). Reliability data was not collected on the assessment measures.

## Results

### *TeachTown: Basics* computer program

Fifteen of the 22 treatment group students mastered lessons using the *TeachTown: Basics* software program; seven students did not master a lesson in the three-month time period. The seven students who did not master any lessons were either students where the teacher did not use the program with them regularly (e.g., students with severe behavioral and/or attention issues) or students who did make some progress (i.e., prompting levels were fading and the child was getting more responses correct without prompting), but not enough progress in three months to master any of the computer lessons. Because IQ scores were not available, Brigance baseline data was assessed and the seven students did not have significantly lower scores than the students who did master lessons. Fifteen students in the treatment group did master lessons in three months time with pre-test averages of approximately 40 percent and post-test averages of about 90 percent for the preschool students; the K-1 students had about 58 percent on their pre-tests and 90 percent on average for their post-tests. Pre- and post-tests were assessed for every concept learned in the *TeachTown: Basics* software and used a completely different set of stimuli from the training lessons to ensure that the child did not simply memorize responses and to assess for generalization. Students not achieving mastery are not shown due to post-test data not being available. If a student does not achieve the 80 percent criteria during training exercise, the student does not take a post-test. There was a statistically significant difference at the $p > .0001$ level from the pre-tests to the post-tests ($F(1,13) = 77.18$, $p = .0000008$). The pre-tests and post-tests are a part of the *TeachTown: Basics* program and test the child's knowledge of concepts using a different set of stimuli from the training to ensure that the children are learning the concepts (i.e., targets) and not just memorizing pictures. On average, preschool students mastered lessons in about 43 minutes and K/1 students mastered lessons in about 52 minutes. With the exception of those students who did not master any lessons, all treatment group students ($n$ = 15) mastered an average of 5–6 lessons (20–24 concepts/targets).

## Changes on standardized outcome measures

ANOVAs were performed to test the hypothesis that the *TeachTown: Basics* intervention led to larger increases in the raw language scores of students as measured by the PPVT and EVT compared to control group students. The repeated measures factor was pre- versus post-intervention, and the between-subjects factor was type of intervention (treatment vs. control group). As shown in Figure 1, in the Preschool students, the *TeachTown* group had significantly larger increases (8.82 pre- to 23.36 post-intervention) than the control group (9.67 pre- to 14.92 post-intervention) in the raw scores of the PPVT ($F(1, 21) = 5.03$, $p = .036$), but not the EVT ($F(1, 21) = 0.61$, $p = .444$). In the K-1 students (see Figure 2), no significant differences were observed between treatment groups for either the PPVT or the EVT ($F(1, 21) < 1$ in both cases). For PPVT, $F(1, 21) = 0.32$, $p = .577$; for EVT, $F(1, 20) = 0.82$, $p = .375$.

ANCOVAs were performed to test the hypothesis that the *TeachTown: Basics* intervention led to larger increases over time on the various student sub-scores of the Brigance test compared to control group students. Pre- versus post-intervention was used as a repeated measures factor, type of intervention (treatment vs. control) was used as a between- subjects factor, and grade level was used as a covariate. No significant differences were observed in pre- versus post-intervention scores between the *TeachTown* and control groups for any of the eight Brigance subscores, or on the mean of all eight individual-test scores. Although descriptive, the pre- to post-intervention changes were generally larger for the *TeachTown* group than the control group (see Figure 3); these differences did not reach significance.

## Effect of time spent on *TeachTown: Basics* on outcome

Correlations were done to test the hypothesis that spending more time on the *TeachTown: Basics* program would result in improved performance on the software and on standardized outcome measures. The correlation between the total amount of time spent on the software and the total number of lessons mastered in the software was significant, $r(22) = .53$, $p = .010$. There was a trend of a larger change in Brigance scores the more time the children spent using the program, but one outlier student strongly affected the analysis. The correlation between how many lessons the child mastered and the overall pre-post change on the Brigance was significant, $r(22) = .44$, $p = .042$. Children who mastered more overall lessons during the *TeachTown: Basics* intervention tended to have larger increases in Brigance scores after the *TeachTown* intervention.

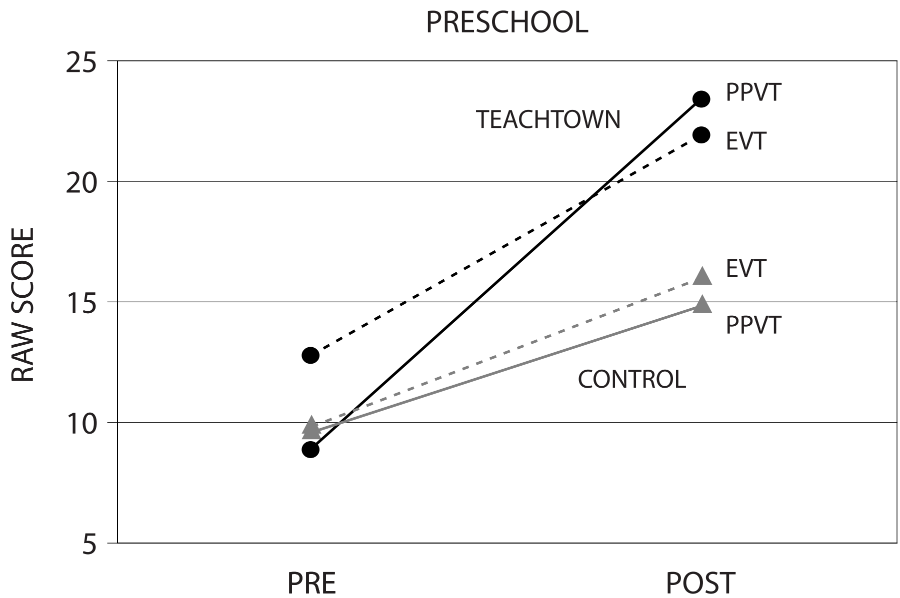


***Figure 1*** **Changes in raw scores on the PPVT-III and EVT for the students in the preschool classrooms (*n* = 24)**

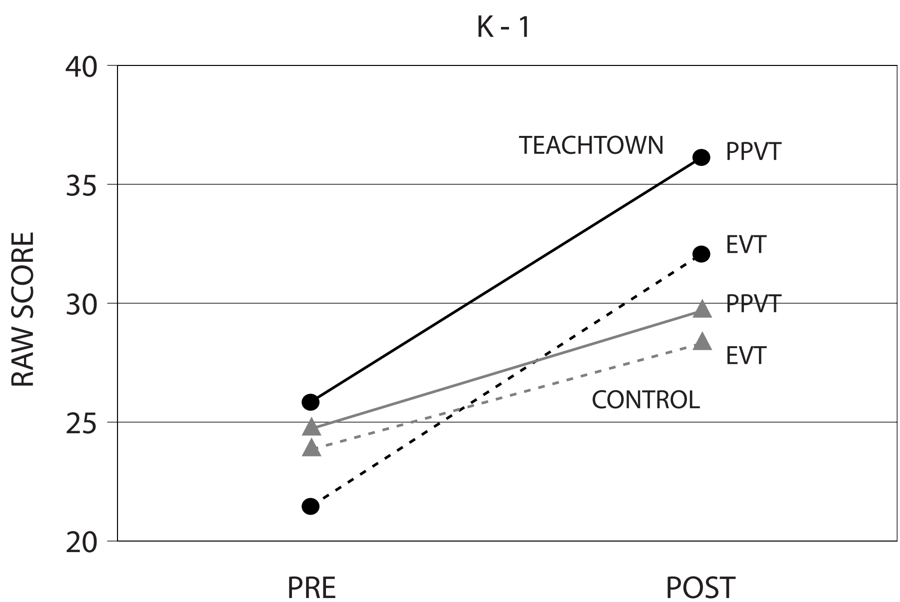


***Figure 2*** **Changes in raw scores on the PPVT-III and EVT for the students in the K-1 classrooms (*n* = 23)**

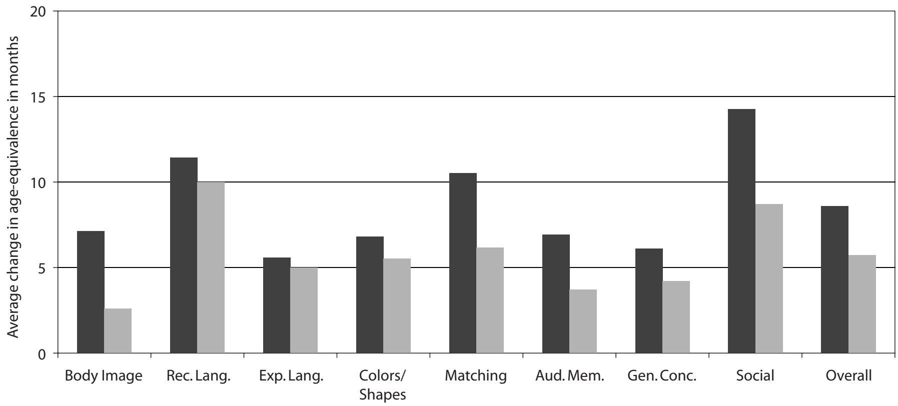


***Figure 3*** **Changes in age-equivalence scores on the Brigance in months for all participants (*N* = 47)**

*Note*. Rec. Lang. = Receptive Language; Exp. Lang. = Expressive Language; Aud. Mem. = Auditory Memory; Gen. Conc. = General Concepts. Average change for each domain is shown with pre-post changes for the *TeachTown: Basics* group and the control group. The black bars represent the treatment group and the gray bars represent the control group.

## Discussion

The majority of students using *TeachTown: Basics* software for approximately 20 minutes a day on school days over three months demonstrated significant progress in the software program as shown by mastered lessons across the four learning domains of *TeachTown: Basics*. These results extend previous research showing effectiveness of the software in teaching the four learning domains (Receptive Language, Social Understanding, Life Skills, and Cognitive/Academic) in a parent-implemented study with 15-minute computer sessions three days a week over two months (Whalen et al., 2006). Children who used the program for more time also showed larger gains than the children who used the program for less time. These findings support the idea that CAI may be an effective and practical tool for teaching several types of skills to children with ASD in a classroom environment.

Children in the *TeachTown: Basics* group performed better overall across all measures than the children in the control group on standardized outcome measures, even though many of these findings were not statistically significant. This may suggest that the children were able to generalize their knowledge from the software to the assessments, but further research is needed on the generalization effects of this type of intervention. This is the first study to look at standardized outcome measures after implementation of computer-assisted instruction for children with ASD. Future studies may benefit from larger sample sizes and increased length and amount of interventions.

Better results in some skills may be due to the strengths of the *TeachTown: Basics* program in targeting these areas of functioning. For instance, significant changes in receptive language for the preschool children in the *TeachTown: Basics* group was anticipated considering that the *TeachTown: Basics* program requires the child to listen prior to responding and only reinforces responses that are correct (with and without prompting). This is unlike many other types of computer programs for young children that allow the child to click through without performance-based contingencies.

Gains in the area of auditory memory were anticipated and though not statistically significant, the outcome in this area may have a substantial clinical impact for many of the children in this study. Auditory processing skills, or listening skills, are pivotal in learning to learn skills, and improving these skills is likely to lead to gains in language, academics, and social skills (e.g., Ahissar et al., 2000). The computer may be a very effective tool for teaching these skills (e.g., Brett, 1997) and the results from this study provide some promise that *TeachTown: Basics* may be a good tool for building auditory processing skills.

In addition to the software component, teachers were asked to engage the child in 20 minutes per day of supplementary off-computer activities (Connection Activities), printable from the *TeachTown: Basics* software. Teachers were instructed to implement activities in either 1:1, small group, or circle-type activities. Although teachers did not document the exact activities or times, all teachers reported that they regularly implemented these activities and showed examples of work their students created during these activities. Some of the results of this intervention may be due to the implementation of the off-computer activities, but it is difficult to assess as this part of the intervention was not measured as carefully as the computerized intervention due to budget and time constraints of the teachers. This fact is important in that special educators are often expected to collect and report outcomes in the classroom, but it is often difficult to do so. Having programs such as *TeachTown: Basics* can improve effectiveness and efficiency of data collection and reporting, but more work is needed on reporting progress on the off-computer parts of the program as well as computer instruction time.

Although the data offers promise for using *TeachTown: Basics* to teach children with ASD in a natural classroom environment, this study had several limitations. First, not all teachers followed the *TeachTown: Basics* curriculum and instead used the expert mode (in which the teacher selected lessons for the students rather than the computer selecting lessons for the student based on student performance), which may or may not have been appropriate for the student, and which made the variability in the dependent variables greater. Second, although teachers reported use of the Connection

Activities, data was not collected, making fidelity of implementation and effectiveness of this part of the intervention difficult to interpret. Third, the small amount of time using the program may have impacted the efficacy of the study. In general, it is recommended that teachers use *TeachTown: Basics* for 40 minutes per day, but due to the experimental nature of this intervention, teachers were only able to use the program for 20 minutes per day. Fourth, although some generalization effects may be seen in the improved standardized outcome scores, the lack of data from the Connection Activities leaves the question of whether the skills generalize still unknown. Fifth, although developmental profiles were done using the Brigance, no IQ assessments were completed and no objective measurement of autism severity was done. Because of the small amount of funding and time for this research, the Brigance and the CARS were used to establish basic profiles of the students, but comprehensive assessments and student profiles would have made the study more complete. Sixth, data was not collected on non-*TeachTown* activities, so it is not clear how the students spent their time in their regular school days. Seventh, reliability data was not collected for the assessment measures. Finally, the short amount of time for intervention does not provide information about maintenance over time.

Like other studies, this study suggests that CAI may have benefits for children with ASD, but CAI may have some limitations. First, and probably most important, it is not yet known whether skills learned on the computer will generalize to the natural environment. Any intervention that cannot demonstrate generalization to the natural environment offers little to the child. The results from this study (by showing improvement on standardized outcome measures) and others (Hetzroni and Tannous, 2004; Bernard-Opitz et al., 2001) suggest that generalization may be occurring from CAI, but much more research is needed. Second, computers are not available in every environment. For instance, some special education classrooms do not even have a computer available, and some families do not have a computer or access to the Internet. This fact is rapidly changing, however, and initiatives for making computers available to all children are essential as using a computer is an important functional life skill. In addition, studies show that children with early computer use have better outcomes later in life, and this effect begins at a very young age. For example, Xiaoming and Atkins (2004) found that exposure to computer before preschool was associated with development of preschool concepts and increased cognition. Third, computers are not motivating for all children. This is true, but, to date, there is no intervention available that is motivating for all children, and the computer is no exception. To resolve this issue, the burden falls on the instructors to either make the computer motivating by using other reinforcers or to use alternative strategies for instruction that are motivating.

Fourth, some people worry that using computers at a young age may have negative effects that are similar to television. There is no research supporting this; in fact, studies so far indicate the opposite (e.g., Xiaoming and Atkins, 2004). Finally, computers may be hard for some people to use. This is a real problem, as not all parents, teachers, clinicians, and so on have computer skills themselves. To address this issue, the burden falls on the developers of these programs and on researchers to provide better training and implementation programs that are cost-effective and that result in rapid and effective implementation by the end-users. This could be done through better design of the programs themselves (i.e., making them more user-friendly), providing webinar or video trainings, providing strategy guides, and providing communication systems for addressing issues quickly as they come up. *TeachTown: Basics* provides solutions for many of these issues, but more research in this area is critical and more commitment to improving existing interventions and integrating technology into special education classrooms is needed.

Although results from this study are preliminary and further research is needed, it is important to consider the impact of this kind of intervention on educating children with ASD. If this type of intervention, through a series of research studies, proves to be effective over time and across learning domains, results in generalization to the natural environment, and results in improved language, cognitive, and social behaviors in children, CAI may become a critical intervention for ASD, and possibly other special needs children. The advantages of CAI, particularly in a school environment, but also in home programs, are as follows: 1) treatment delivery is consistent and predictable, yet can be individualized to meet the needs of each student; 2) data collection is immediate, extremely accurate, and requires little to no training for the adult; 3) reporting possibilities are enormous and offer data on the child's progress, usage of treatment providers, anecdotal session notes, generalization data, fidelity of implementation, and so on, with very little effort or time needed to generate these reports; 4) instruction can be evidence-based and effective, with little training needed for service providers; 5) computers can be highly motivating for children, resulting in increased attention to task, increased positive social behaviors, and decreased problem behaviors; and 6) computers may provide detailed data that was never possible before, or that was too time-consuming to evaluate for looking at the effectiveness of various parts of an intervention (e.g., assessing what prompting, reinforcement, or other teaching strategies are most effective).

Based on the success of this research, the investigators and LAUSD teachers have decided to continue usage of *TeachTown: Basics* for the remainder of the school year in order to assess the effects of usage of the program for a longer period of time (i.e., 6 months instead of only 3) for the treatment group. In addition, the *TeachTown: Basics* program will be implemented with the students in the control group in order to conduct a within-subject analysis. To measure collateral effects of this intervention, videotapes of the students throughout this study will be analyzed by blind raters to look for differences in motivation, expressive language, behavior problems, and so on. These follow-up studies are important next steps for better understanding the effectiveness of the *TeachTown: Basics* program and to prepare for larger follow-up research. In addition, studies will be conducted looking more closely at which aspects of the program are most effective and which skills are most likely to generalize.

## References

Ahissar, M., Protopapas, A., Reid, M. & Merzenich, M. (2000) 'Auditory Processing Parallels Reading Ability in Adults', *Proceedings of the National Academy of the Sciences* 97(12): 6832–6837.

Bernard-Opitz, V., Sriram, N. & Nakhoda-Sapuan, S. (2001) 'Enhancing Social Problem Solving in Children with Autism and Normal Children through Computer-Assisted Instruction', *Journal of Autism and Developmental Disorders* 31(4): 377–384.

Bondy, A.S. & Frost, L.A. (1994) 'The Picture Exchange Communication System', *Focus on Autistic Behavior* 9: 1–19.

Bosseler, A. & Massaro, D. (2003) 'Development and Evaluation of a Computer-Animated Tutor for Vocabulary and Language Learning in Children with Autism', *Journal of Autism and Developmental Disorders* 33(6): 653–672.

Brett, P. (1997) 'A Comparative Study of the Effects of the Use of Multimedia on Listening Comprehension', *System* 25(1): 39–53.

Brigance, A. (2004) *The Brigance Inventory of Early Development*. North Billerica, MA: Curriculum Associates.

Bryan, L. & Gast, D. (2000) 'Teaching On-Task and On-Schedule Behaviors to High-Functioning Children with Autism via Picture Activity Schedules', *Journal of Autism and Developmental Disorders* 30(6): 553–567.

Charlop-Christy, M.H., Carpenter, M., Le, L., LeBlanc, L.A. & Kellet, K. (2002) 'Using the Picture Exchange Communication System (PECS) with Children with Autism: Assessment of PECS Acquisition, Speech, Social-Communicative Behavior, and Problem Behavior', *Journal of Applied Behavior Analysis* 35: 213–231.

Charlop-Christy, M.H., Le, L., & Freeman, K.A. (2000) 'A Comparison of Video Modeling with In Vivo Modeling for Teaching Children with Autism', *Journal of Autism and Developmental Disorders* 30: 537–552.

D'Ateno, P., Mangiapanello, K. & Taylor, B.A. (2003) 'Using Video Modeling to Teach Complex Play Sequences to a Preschooler with Autism', *Journal of Positive Behavior Interventions* 5: 5–11.

Dettmer, S., Simpson, R.L., Myles, B.S. & Ganz, J.B. (2000) 'The Use of Visual Supports to Facilitate Transitions of Students with Autism', *Focus on Autism and Other Developmental Disabilities* 15: 163–169.

Dunn, L. & Dunn, L. (1997) *Peabody Picture Vocabulary Test-III (PPVT-III)*. Circle Pines, MN: 3rd. American Guidance Service.

Ganz, M.L. (2006) 'The Costs of Autism', in S.O. Moldin & J.L.R. Rubenstein (eds), *Understanding Autism: From Basic Neuroscience to Treatment*, 1st Edition (pp. 475–502). Boca Raton, FL: CRC Press.

Hetzroni, O.E. & Tannous, J. (2004) 'Effects of a Computer-Based Intervention Program on the Communicative Functions of Children with Autism', *Journal of Autism and Developmental Disorders* 34(2): 95–113.

Huebner, R.A. (2001) *Autism: A Sensorimotor Approach*. Gaitherburg, MD: Aspen Publishers.

Keller, J. & Suzuki, K. (1988) 'Use of the ARCS Motivation Model in Courseware Design', in D. Johansson (ed), *Instructional Designs for Microcomputer Courseware* (pp. 401–434). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kinzie, M. (1990) 'Requirements and Benefit of Effective Instruction: Learner Control, Self-Regulation and Continuing Motivation', *Educational Technology Research and Development* 38(1): 5–21.

Koegel, R.L. & Mentis, M. (1985) 'Motivation in Childhood Autism: Can They or Won't They?' *Journal of Child Psychology and Psychiatry* 26: 185–191.

Malone, T. (1982) 'Heuristics for Designing Enjoyable User Interfaces: Lessons from Computer Games', *Proceedings of the First Major Conference on Human Factors in Computer Systems*. Gaithersburg, MD: ACM.

McAfee, J. (2002) *Navigating the Social World: A Curriculum for Individuals with Asperger's Syndrome, High-Functioning Autism and Related Disorders*. Arlington, TX: Future Horizons.

McLeskey, J. (2004) 'The supply of and demand for special education teachers'. *The Journal of Special Education* 31(1): 5–21.

Mesibov, G. (1997) 'Formal and Informal Measures on the Effectiveness of the TEACCH Programme', *Autism* 1(1): 25–35.

Nikopoulous, C.K. & Keenan, M. (2004) 'Effects of Video Modeling on Social Initiations by Children with Autism', *Journal of Applied Behavior Analysis* 37: 93–96.

Padma, A.G. & Ross, S.M. (1987) 'Using Computer-Assisted-Instruction to Personalize Arithmetic Materials for Elementary School Children', *Journal of Educational Psychology* 79: 72–78.

Schilling, D.L. & Schwartz, I.S. (2004) 'Alternative Seating for Young Children with Autism Spectrum Disorder: Effects on Classroom Behavior', *Journal of Autism and Developmental Disorders* 34: 423–432.

Schreibman, L. (1988) *Autism*. Beverly Hills, CA: Sage Publications.

Schreibman, L., Whalen, C. & Stahmer, A. (2000) 'The Use of Video Priming to Reduce Disruptive Transition Behaviors in Children with Autism', *Journal of Positive Behavior Interventions* 2(1): 3–11.

Schopler, E., Reichler, R.J. & Renner, B.R. (1986) *The Childhood Autism Rating Scale (CARS)*. Los Angeles, CA: Western Psychological Services.

Traynor, P. (2003) 'Effects of Computer-Assisted-Instruction on Different Learners', *Journal of Instructional Psychology* 30: 137–151.

Whalen, C., Liden, L., Ingersoll, B., Dallaire, E. & Liden, S. (2006) 'Positive Behavioral Changes Associated with the Use of Computer-Assisted Instruction for Young Children', *Journal of Speech and Language Pathology and Applied Behavior Analysis* 1(1): 11–26.

Williams, K.T. (1997) *Expressive Vocabulary Test (EVT)*. Circle Pines, MN: American Guidance Service.

Xiaoming, L. & Atkins, M. (2004) 'Early Childhood Computer Experience and Cognitive and Motor Development', *Pediatrics* 113(6): 1715–172.

**Appendix: *TeachTown*: Basics sample content and concepts**

| *Domain* | *Subdomain* | *Lesson content and concepts* |
|---|---|---|
| Academics and Cognitive Skills | Math | Shapes, numbers, most and fewest concepts, numeral-quantity matching, math symbols, addition, subtraction, number lines, fractions |
| | Reading – Decoding<br>Reading – Text Discrimination<br>Reading – Early Literacy | Matching letters, letter identification, phonics, word matching, upper and lower case letter matching, initial sound identification, book awareness, rhyming, sight words, ending sound identification, reading symbols, spelling |
| | Categorization | Identical matching, non-identical matching, functional relationships, associations, negation, same and different, opposites, gender concepts, sorting |
| | Problem Solving | Comparisons, riddles, what's missing, what's wrong, silly stuff, fact questions (yes and no questions) |
| Receptive Language – Comprehension Skills | Language Development | Vocabulary – zoo animals, sea animals, farm animals, neighborhood animals, insects, birds, transportation, household items, play items, sports, make believe, pretend, what's real |
| | School Readiness | Play vocabulary, classroom vocabulary, music instruments |
| | Semantics | Colors, descriptors, actions, plurals, positions, prepositions, multiple cues (1, 2, 3, 4-term semantics), features |
| | Community Life | Body parts, environmental sounds, nature, body functions, community spots, community places, tools, career tools, measurement tools, nature and man-made concepts |

**Appendix:** ***Continued***

| *Domain* | *Subdomain* | *Lesson content and concepts* |
|---|---|---|
| Social – Emotional Skills | Social Knowledge | People, eye gaze, joint attention, face matching, good friends |
| | Emotion Recognition | Emotions, feelings |
| Independence and Life Skills | Awareness and Regulation | |
| | Functional Skills | Time telling, environmental print, neighborhood signs, money, safety |
| | Self Awareness | Food vocabulary, clothing vocabulary, personal needs |