

INCREASING PROBLEM SOLVING IN A SPECIAL EDUCATION CLASS BY TEACHING
TALK ALOUD PROBLEM SOLVING (TAPS)

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Although there is extensive research demonstrating the benefits of teaching problem solving repertoires to typically developing individuals, there is little research on the effectiveness of these kinds of procedures with individuals with special needs. In this study, a group of special education students in a public school were taught problem solving skills using a curriculum called Talk Aloud Problem Solving (TAPS). TAPS teaches students five problem solving skills and five active listening skills. This study utilized a multiple baseline design to examine whether training in TAPS would change the way that students solve problems and increase their accuracy when solving problems. In addition, a reversal design was used for each participant, consisting of the presence and the removal of the active listener during different stages of the study. After TAPS training and guided practice sessions, all students demonstrated new problem solving repertoires and their accuracy improved. For some students, having an audience (an active listener) was necessary to maintain their behavior. Further research is needed to determine how to teach students to be their own active listener.

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By

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INTRODUCTION

Teachers must prepare students for the grades ahead and for the world after graduation. Students not equipped with the skills needed to be successful in school may suffer from academic, behavioral, and attendance problems. Additionally, when students fall behind multiple school years, it becomes increasingly difficult to help them catch up. This can be very discouraging to the student and can make participation aversive. These problems are only magnified for students with special needs, as well as for the teachers and parents of these students. Many times, year after year of poor performance by students with special needs leads to low expectations from teachers and parents, which results in minimal progress each year. As a result, the student has absolutely no hope of catching up with his or her peers. The lack of progress is usually attributed to the individual's disability, rather than to a lack of skills. (Grimes, 1981; Gardner, 1983; Anderson, 1992; Herrnstein & Murray, 1994).

One key skill area shown to be directly related to academic achievement and intelligence is problem solving. "High-aptitude" students show a similar pattern in approaching and solving problems, which differs from the one shown by "low-aptitude" students (Bloom & Broder, 1950). Interestingly, researchers have shown that these patterns are not innate and that students can benefit if they are taught problem solving skills directly. For example, Woods (1998) taught a set of problem solving skills using Whimbey and Lochhead's (1985) book, *Problem Solving and Comprehension*, to college students at McMaster University. These skills were taught through a series of four college classes spanning 120 hours. Eight different measures were acquired either through assessments or self-reports. Participants showed improved reading comprehension, particularly with inferential questions, improved vocabulary acquisition, writing and editing

skills, math performance, and direction following. In addition, the skills training improved participant performance on IQ tests and other standardized tests.

Whimbey and Lochhead's method is based on Bloom and Broder (1950), who identified four qualities of good problem solvers: understanding the nature of the problem, understanding the ideas contained in the problem, general approach to the solution of the problem, and attitude toward the solution of the problem. Lochhead and Whimbey (1982) operationalized the qualities Bloom and Broder identified and added a fifth quality, *thinking aloud*. They placed an emphasis on the problem solver verbally communicating the steps of the problem solving process to an active listener. The importance of the talking out loud not only allows the teacher or active listener to understand the student's thinking process, but also serves to reinforce the student's effort while solving the problem. The student's own verbal behavior is also reinforced by correct solutions or the next step forward (see Goldiamond, 1976). The active listener's job is to follow along with the problem solver and keep the problem solver talking out loud. Whimbey and Lochhead called their method Think Aloud Pair Problem Solving (TAPPS). The TAPPS method was later adopted by the Stress on Analytical Reasoning (SOAR) program at Xavier University. Students who participated in the program had SAT gains of 120 points (Hunter, J., Jones, L., Vincent, H., and Carmichael, JW, Jr., 1982) and were twice as likely to pass math and science classes than students who did not participate in the program (Carmichael, 1982). During the length of the program, more African American students were sent to medical and dental schools than from any other college in the U.S. (Association of American Medical Colleges, 1984).

Robbins (2014) developed a program for younger learners called *Learn to Reason with TAPS: A Talk Aloud Problem Solving Approach* (TAPS), which was based off of the earlier TAPPS program developed by Lochhead and Whimbey (1982). Robbins expanded on the

problem solver role by redefining the qualities as: has a positive attitude, breaks the problem into pieces, is careful, is active, and avoids guessing. The role of the active listener was expanded by adding five qualities: checks for accuracy, follows along, catches mistakes, acts like a teacher, and uses encouraging words. To ensure that the students are equipped with all of the qualities of good problem solvers and active listeners, the program goes through five phases. The phases are designed to train each quality so that the students can solve any problem they may encounter. The qualities are taught one at a time, then practiced in paired problem solving exercises before being practiced independently. TAPS is used extensively at Morningside Academy, a non-profit school that serves 1st through 9th grade students, some with mild disabilities, all of whom have fallen behind in school. Morningside Academy's students regularly experience two years of academic gains during a single school year (Johnson, 1997). The students also change from being tentative, reluctant, or careless to enthusiastic problem solvers (Robbins, 2011). Although there is no data showing the individual effects of specific programs, TAPS is considered to be an integral and necessary part of the Morningside curriculum.

Although there is extensive research regarding teaching problem solving to typically developing individuals, there is relatively little regarding teaching these repertoires to students with special needs. Montague and Candace (1986) provided strategy training to a group of six students with learning disability to improve mathematic problem solving. The strategy training consisted of eight steps: read the problem aloud, paraphrase the problem aloud, visualize (draw a representation of the problem), state the problem, hypothesize, estimate, calculate, and self-check. This strategy training lead to an improvement in solving math problems (Montague & Candace 1986). In an extension, Montague (1992) added a metacognitive training component to the mathematic problem solving strategy. The metacognitive training consisted of three

components: self-instruction, self-questioning, and self-monitoring. Students who also received the metacognitive training component showed greater improvements in mathematic problem solving than students who only received the strategy training component (Montague 1992).

Case (1992) also studied how to teach mathematic problem solving to students with learning disabilities. This experiment used a method of direct instruction by combining scaffolding and Socratic dialogue, along with the same metacognitive approach used by Montague (1992). The results of this study showed improvement by all participants on addition and subtraction mathematic problems (Case, L., Harris, K., Graham, S., 1992). One issue with most of the existing research on teaching problem solving skills to special education students is that the data collection has focused mainly on accuracy on tests. None of the research available included data on the actual problem solving behaviors. Because of this, questions remain regarding what exactly the participants learn during these procedures.

The purpose of the current study was to assess whether teaching the TAPS repertoires to a group of students with special needs in a North Texas middle school would change the way they solve problems and increase their accuracy when solving problems.

METHOD

Participants

The participants in this study were three middle school participants enrolled in a classroom that serves students with special needs. To participate in this study, participants needed to be able to read at a second-grade level or above, and be enrolled in the special education program at the participating middle school.

Eric, a seventh-grade male student diagnosed with autism and speech impairment, was assessed at a 2nd grade reading level and a 2nd-3rd grade mathematic level. Eric was a student that had difficulty reading quickly due to his speech impairment. He could read silently and answer questions to demonstrate comprehension of the text much faster than if he was reading out loud. Eric enjoyed math problems that he could do with minimum writing. He had a history of throwing tantrums to get out of reading assignments, and any other subject material that included writing. Eric had been using the Headsprout Reading Program for a few months prior to this study to improve his reading, and engaged in speed writing exercises to make writing more fun.

Kitty, a seventh-grade female student diagnosed with autism and intellectual disability, was assessed at a 3rd grade reading level and 2nd-3rd grade mathematic level. Kitty enjoyed reading and actively engaged in reading books from the library. She enjoyed doing schoolwork, but had difficulty staying on task while in class. In class, she required heavy prompting to complete assignments and to listen to the teacher.

Charles, an eighth-grade male student diagnosed with intellectual disability, was assessed at a 3rd grade reading level and 2nd-3rd grade mathematic level. Charles enjoyed working with others and pleasing his teachers. He often had trouble staying on task while in class. At the end of class his notes would often be incomplete due to falling asleep in class. Charles struggled to

complete tasks or problems that included multiple steps. To accommodate him in class, Charles had graphic organizers, manipulatives, and one-on-one assistance from a teacher or one of the staff members in the room.

Setting

The following study was conducted in a special education classroom at a public middle school in North Central Texas. The classroom was the same used every day by the participants, and included six middle school participants (6th-8th graders).

The classroom layout is shown in figure 1. The room contained three teacher desks, six individual student desks, two tables placed parallel to each other, and one dinner room style table with four chairs. The study took place in those areas in the classroom that had a table and at least three chairs or two desks. Any area of the room was utilized that was not disturbing the rest of the class. During the study all of the students, participants and staff could have been in the room, or there could have been no others in the room due to the schedule for the day. If there were other students in the room that were not participants in the study, they were not included in the activities related to the study. If there were other subjects in the class that were on the same stage in TAPS or further along, they were included as either active listeners or problem solvers to work with.

Materials

A series of assessments were used to obtain the participant's current reading and mathematic levels. To assess current reading levels, the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) was used. To assess current mathematic levels, the Saxon Homeschool Placement Test and the Woodcock Johnson III were used.

The problems chosen for this study included problems up to two grade levels under and two grade levels above the participant's current reading and math level. The pre-test and post-test consisted of eight logic problems obtained from one of these three books: *Logic Safari Book 2 Grades 2-3*, *Logic Safari Book 2 Grades 3-4*, or *Gifted and Talented Reading Workbook for Ages 6-8* (see Appendix F for examples of these problems). The between lesson probes consisted of four problems that ranged from both two grade-levels under and above each participant's current performance. The problems for the between lesson probes came from the same books used for the pre-test, and a new book *Graphing for Grades 2 and 3*. The class probes consisted of three problems from the same books used for the between lesson probes. Testing materials for all tests and probes included two pencils, two pieces of blank paper, a timer, and the pre-test.

The Learn to Reason with TAPS: A Talk Aloud Problem Solving Approach Packet Materials for TAPS (Robbins, 2014) included observation data sheets to record the presence or absence of TAPS qualities (image of this data sheet can be found in Appendix C), TAPS participant and teacher workbook, and active response cards (image of the active response cards can be found in Appendix E), and Slapjack game cards. A separate data sheet was created for taking data during the Slapjack game (image of the Slapjack data sheet can be found in Appendix D). The TAPS teacher workbook included an overview of all the lessons required to train an individual in TAPS, along with scripts and guided lessons to teach TAPS. The TAPS participant workbook includes TAPS vocabulary, phrases and qualities of good active listeners and problem solvers.

Measures

The dependent variable for this study was accuracy of solving problems. Accuracy was obtained by dividing the total number of questions correct by the total number of problems

attempted.

This study also measured the occurrence of the five problem solving qualities in participants. If the participant demonstrated any of the five problem solving qualities while solving a problem, then that quality was marked as present. The five qualities of good problem solvers are: having a positive attitude, being careful, being active, avoiding guessing, and breaking the problem into parts. This study utilized the same data collection sheet and behavioral definitions as outlined in Robbins (2014). Having a positive attitude was scored when the participant made any positive out-loud statement when presented with a problem (saying out loud; “This problem looks tough, but I know I can do it,” or “I bet I have all the information I need to solve this problem”). If the participant did not say anything or made a negative statement (“This is way too hard; or “I can’t do this.”), then having a positive attitude would not be marked present on the data sheet. Being careful was scored when the participant did anything that indicated the participant read the information in the problem (using their finger to read along, reading out-loud, or covering up information before it was needed). If the participant stayed silent and/or kept his/her hands still only staring at the problem, then being careful was not marked as present. Being active was scored when the participant wrote on the paper (underlining words, making tables and diagrams, or making notes). If the participant made no marks on his/her paper, then being active was not marked as present. Not guessing is one of the qualities, but also a quality that cannot be observed. This quality was always given, unless the participant started to quickly mark answers without reading the question. Breaking the problem into parts was scored if the participant wrote out the math steps for the questions or separated the information from the question on the page. If there were no problems worked out on the paper

then being active was not marked as present. Active listening qualities were not directly measured during this study.

During this study, we also measured the identification of examples and non-examples of good problem solvers and active listeners. Since we only used this data as a measure for the participants to move on to the next phase of training we did not include it. A correct was scored if the participant answered “good” when read a sentence that a good problem solver or active listener would say. An incorrect was scored if the participant answered “not good” when read a sentence that a bad problem solver or active listener would say. A pass was scored if the participant answered “I don’t know,” or “I’m not sure” when read a sentence of either a good or bad problem solver or active listener.

Experimental Design

A multiple baseline design across participants was used for this study. In addition, a reversal design was used for each participant, consisting of the presence and the removal of the active listener during different stages of the study. A diagram of the experimental design can be found in Figure 2. The entire study consisted of five stages. During the first stage, all participants were administered the pre-test. During the second stage, Eric began TAPS training, Kitty and Charles were administered the pre-test for a second time. During the third stage, Eric was administered the post-test, Kitty and Charles began TAPS training. During the fourth stage, Kitty and Charles were administered the post-test. During the fifth stage, all participants were administered the class probes.

PROCEDURES

Assessments

Before baseline began the DIBLES, Saxon Homeschool Placement Test, and the Woodcock Johnson III were administered. Performance on these assessments did not affect eligibility. The results from the assessments guided the creation of the pre-tests, class probes, and the post-test. The DIBLES scores dictated what kind of reading problems would be used during the study. The Saxon and Woodcock Johnson scores dictated what kind of math problems would be included during the study.

The DIBLES assessment was administered individually in the same classroom the participants used every day. The investigator asked the participants to be seated at one of the tables in the back of the classroom. Once seated the investigator stated; “Today you will be reading me a short story. Try your best to read as much out loud as you can in one minute. Don’t worry if you make a mistake just keep going.” The participants read three stories ranging from first, second, and third grade reading levels and were included in the DIBLES manual. After each reading, the number of words correctly read per minute was recorded onto the data sheet provided in the DIBLES manual.

The Saxon Homeschool Test was administered in the same classroom the participants used every day. The investigator asked the participants to be seated. Once seated the investigator stated; “Today you will be taking a test. Try your best and work individually on this test. You will have 45 minutes to finish as much of the test as you can. If you come across a problem you don’t know how to do, try your best to work it out and give your best answer. When done, or if you need a restroom break, raise your hand and I will collect your test and materials.”

The Woodcock Johnson III was administered in the same classroom the participants used every day. The investigator asked the participants to be seated. Once seated the investigator stated; “Today you will be taking a test. Try your best and work individually on this test. You will have 3 minutes to finish as much of the test as you can. If you come across a problem you don’t know how to do, try your best to work it out and give your best answer. When done, raise your hand and I will collect your test and materials, or I will let you know when three minutes is up.”

Baseline

During baseline assessment, the pre-test, consisting of eight brain teaser problems on each participant’s performance level was administered. The purpose of the pre-test was to measure the accuracy of problem solving and the presence, or absence of a set of problem solving behaviors.

Before testing began the investigator stated; “Today you will be taking a test. Try your best and work individually on this test. You will have 45 minutes to finish as much of the test as you can. If you come across a problem you don’t know how to do, try your best to work it out and give your best answer. When done, or if you need a restroom break, raise your hand and I will collect your test and materials.” When testing began, the investigator passed out the testing materials. While the participants worked on the test, the investigator remained at the desk. If a participant asked for assistance, then the investigator stated to the participant; “Try your best and feel free to work the problem out on your paper”. If one of the participants requested a restroom break the investigator would gather the testing material until the participant returned to their desk. Once the participant returned to the test, the investigator provided the participant with the

testing material and asked the participant to continue where they left off. Once the participant was finished or time was up, the investigator collected the testing materials.

TAPS Training

TAPS training began the day after the participants completed the pre-test. The training consisted of five lessons. A scripted, step-by-step guide on all TAPS training lessons can be found in Robbins (2014). Figure 3 shows a diagram outlining the steps in the TAPS training process.

Lesson 1

During the first lesson the objective was to have the participants first identify, and then verbally recall all five qualities without any assistance for both the problem solver and active listener.

To accomplish this objective the investigator first lead the participants through a guided lesson that introduces the qualities of good problem solvers and active listeners. During this lesson, all participants would read and recite the qualities of good problem solvers and active listeners. The investigator read out-loud sentences that a problem solver or active listener might say, and stated what quality was being demonstrated by the sentence. The participants then stated if that was a good or bad example of the stated quality. If correct, the investigator confirmed the correct answer and explained why the answer was correct to everyone. If incorrect, the investigator would explain what the correct answer was and why, then move on to the next sentence. The participants practiced identifying and reciting the qualities with the active response cards. Each card had one quality of either an active listener or problem solver, and on the reverse side there is an image representing the quality (see Appendix E for an example of the active response cards). During a practice session, the participants shuffled the 5 problem solver cards.

The participants would pick one card at a time, look at the image, say the quality, and check to see if they were correct. If successful the card was placed in a “correct” pile, if incorrect the card was placed in an “incorrect” pile for the participant to review again later. This process was repeated until there were no cards in the “incorrect” pile. The participants continued this process with the active listener qualities cards.

After the participants had all the cards for Problem Solver, and active listener qualities in the “correct” pile, the investigator verbally asked the participants; “Name the five qualities of good problem solvers, and the five qualities of good active listeners.” The participants met the objective for this lesson if they could verbally recall all five qualities without any assistance for both the problem solver and active listener. If the participants could not recall all five qualities of the problem solver or active listener, they would continue to practice with the Active Response cards until successful.

Lesson 2

The second lesson was designed to introduce a list of TAPS vocabulary words. The criterion for completing this lesson was to read out loud the fifty-eight TAPS words listed on the TAPS Vocabulary page in the Participant Workbook.

To begin the second lesson the participants all opened their participant workbooks to the last page (titled TAPS Vocabulary Words). The investigator led the participants through the guided lesson stating that these words are the kinds you will hear good problem solvers use. The investigator, while modeling in front of the participant(s) read out-loud the first three TAPS words on the list and requested that the participant(s) read out loud the list chorally. The participants all read the list of vocabulary words out-loud. When finished, the investigator and participants had a discussion about other words that could be on the list. If the participants were

uncomfortable or refused to read out-loud, they were allowed to wait until they were ready or request a more private area to read in. After all participants had read the vocabulary words out loud, this lesson was completed.

Lesson 3

In the third lesson participants practiced identifying TAPS vocabulary words from the list of forty-nine sentences on the TAPS sentences page in the participant workbook. The purpose of this lesson was to introduce the participants to using the TAPS process in pairs. The criterion for completing this lesson was to circle all the TAPS words inside the sentences located on the TAPS sentences page in the participant workbook.

To begin the third lesson the participants opened their participant workbooks to page 3 (titled TAPS Vocabulary in Sentences). The investigator led the participants through a guided lesson discussing that the TAPS words we learned in the previous lesson may be said by ourselves or others when solving problems. The investigator lead the participants through the guided lesson, modeling how to identify and circle the TAPS vocabulary words in sentences provided by the participant workbook. While modeling how to identify and circle the TAPS words, opportunities were provided for the investigator to display good and bad examples of problem solvers, and the participants to practice being active listeners. The investigator would talk out-loud every step of the process, then become silent in order to prompt the participant to provide a reminder to talk out-loud. Another tactic used was to leave a TAPS word uncircled and ask the class; “Did I find all the TAPS words?” If the participants remained silent or gave an incorrect statement, the investigator modeled a correct statement and continued the lesson. If the participants gave a correct statement they were verbally praised and the lesson continued.

After the investigator modeled three sentences in front of all of the participants, one participant was asked to work a couple sentences with the investigator. The participant was selected because of their enthusiasm with the lesson and willingness to work in front of the class. If the participant was unwilling another participant would have been asked. The participant was told that they would be the active listener, and their main purpose was to make sure the problem solver continued talking out-loud, and circling all the TAPS words. If the participant provided the prompts to keep talking, keep searching for TAPS words, and/or verbal praise to the problem solver for correct work, the participant was verbally praised. If the participant missed an opportunity, the investigator would prompt the participant with a question to help them come up with a correct response (“What could someone say to keep me talking out-loud?” or “What could someone say to remind me to double-check for more TAPS words?”). If the participant still could not come up with a correct response, the investigator would model a correct response and give the participant another opportunity to make the correct statement. After the first sentence was complete, the investigator and participant switched roles. The participant began searching for TAPS words, and the investigator became the active listener. If the participant was talking out-loud their process and identifying all of the TAPS words, the investigator would provide verbal praise. If the participant became silent or missed a TAPS word, the investigator would provide a verbal prompt to continue talking out-loud or double-check for more TAPS words.

After the participant and investigator completed the two sentences, the participants were assigned a partner to work with and practiced identifying TAPS words together. Each participant was either the problem solver and practiced circling all the TAPS words, or the active listener and provided timely prompts, or praise to the problem solver. The participants would alternate between the two roles as they completed each sentence provided in the participant workbook.

The investigator observed the participants while working on the sentences and provided feedback where necessary. If a participant refused to work, they were allowed to come back to the material when ready or take the work to a more private area of the room. Once all the TAPS vocabulary words have been circled in all the sentences the criterion for completing this lesson was completed.

Lesson 4

The fourth lesson was designed to practice identifying examples and non-examples of TAPS qualities using the Slapjack game. During a round of Slapjack two participants would sit across a table from the investigator and then listen to the investigator read a sentence off a card. The card would then be placed on a table and the participants would race to slap the card. Whoever slapped the card first would then state the sentence read was an example of a good or bad active listener or problem solver. If correct, the participant would keep the card. If incorrect, the participant would return the card to the dealer. The objective of the game was to end with the most cards in your possession as possible. The rules and outline for the Slapjack game can be found in (Robbins 2014, p. 31). The criterion for completing this lesson was to answer at least 90% of attempts correctly during two games of Slapjack.

If any the participants were scoring lower than 90%, the investigators checked the Slapjack data sheets to identify the area that consistently had the most errors. The investigators worked with the participant to improve performance on identifying that missing quality. To improve performance, the participant practiced circling TAPS words in sentences demonstrating that missing quality then practiced playing Slapjack with the missing qualities only, until 90% corrects were scored on every quality. To avoid participants becoming discouraged, if one

participant was continuously beating the others in Slapjack that participant would only play with the investigators until the others caught up.

Lesson 5

The fifth lesson is designed to discuss how the TAPS process can be extended to everyday life. The criterion for completion of this lesson was to answer the three questions on page eight of the participant workbook relating to using TAPS in everyday life. The three questions involved the participant describing an instance that they had experienced when they saw someone trying to solve a problem, and the language they heard the person use. The purpose of this exercise was to demonstrate that the same strategies and language used to solve problems in school can be used to solve problems outside of school. After the questions were answered, each participant read their answers to the class. Once the participants completed this lesson they were ready to participate in demonstrations of the TAPS process with real problems.

Between Lesson Probes

After every TAPS lesson was a between lesson probe (BLP). All BLPs were administered individually and in the same manner described for the assessments. Each BLP consisted of three to four questions of the same difficulty level as the pre-test. The results of the BLP did not have an effect on the participant's continued progress through the training.

TAPS Guided Practice

The TAPS guided practice provided opportunities for the participants to practice using the TAPS repertoires in their own work. Participants practiced identifying at least one example of every problem solver and active listener quality and then practiced solving problems themselves. (These procedures were not included in the *Learn to Reason with TAPS: A Talk Aloud Problem*

Solving Approach.) Figures 4, 5, and 6 show the active listeners assigned to each participant during TAPS guided practice demonstrations.

First, the two investigators modeled the roles of the problem solver and active listener. The participant was seated across the table and provided with the active response cards. At the beginning, the investigator said, “Today you will watch us demonstrate the TAPS process for you. Whenever you see a good quality of a problem solver or active listener, we would like you to hold up the card that has the name of the quality on it.”

During the demonstration, the investigators modeled each problem solving and active listening quality and the participant was given an opportunity to hold up the appropriate card. For example, while the problem solver circled words or essential phrases, the investigators checked to see if the participant held up the “Be Active” card. Sometimes, the investigator would model a trait that was not desirable and ask the participant what quality was missing.

If the participant held up the correct card they were verbally praised. If the participant held up the wrong card, the investigator asked; “What did you see that told you it was that quality?” If the participant could argue why his or her answer was correct, the investigator would accept the answer. Otherwise, the investigator would tell the participant the correct answer. If the participant never made a response the opportunities to participate were marked as a miss for the participant on the data sheet. If the participant missed more than three examples during the guided practice, they would return to playing SlapJack to refresh the examples and nonexamples of the TAPS repertoires.

After two guided lessons with less than three errors, the participant played the role of the problem solver while one of the investigators remained the active listener. Other participants (if present) were provided their active response cards so they could participate. As the participant

began working on the problem, the investigator verbally praised every positive quality demonstrated. If an opportunity to demonstrate a quality was missed, the investigator provided a verbal prompt.

As the participants begin talking out loud without prompting and demonstrated all of the qualities of a good problem solver at least once, the participant and investigator switch roles. The investigator continued to use verbal prompts, as described above. When the participants finished two demonstrations showing all the problem solving and active listening qualities, they were paired off to work on problems together while the investigators observed and provided feedback only when an opportunity to present a quality was missed. Criterion for completing this lesson was to perform all TAPS qualities during problem solving exercises.

Post Test

The participants were administered a post-test identical to the pre-test and administered in the same fashion. The post-Test was designed to measure any change in performance after the participants had received TAPS training. The same questions were used from the pre-test in order to see if there was any overall improvement, or if they could answer problems that they had previously missed, but also to see if the overall approach to test and solving the problems was different.

Class Probes

The day after finishing the post-test, each participant took part in at least three class probes that were all taken at the same time. Each probe consisted of one problem; so, three probes were three problems. Each problem on the class probes had to be incorrectly answered on each participant's pre-test, BLPs, or post-test. This was a much shorter test than any of the others, and the participants had full help from their assigned classroom staff member as their

active listener (for more information of staff member training see Neri, 2016). The participants were in the same classroom they use every day. The investigator asked the participants to be seated. Once seated the investigator stated; “Today you will be taking a test. You will be able to use your active listeners while solving the problems on your test. You will have forty-five minutes to finish as much of the test as you can. When done, or if you need a restroom break, raise your hand and I will collect your test and materials.”

Next, the investigator passed out the testing materials. While the participants worked on the test with their assigned active listener, the investigator waits at the desk.

For Charles, who only had help from a non-TAPS trained teacher up to this point, we provided a fourth and fifth probe with a TAPS trained teacher.

RESULTS

Figure 7 displays the cumulative occurrences of Eric's problem solver qualities (top graph). The problem solver qualities are represented by the five different colored lines on the graph. The x -axis represents the individual questions during each phase. The y -axis represents the cumulative count each problem solver quality. Figure 7 also shows Eric's accuracy of solving problems (bottom graph). The x -axis represents each test. The y -axis represents the participant's accuracy.

Figure 7 shows that on the pre-test Eric demonstrated three problem solver qualities on four out of eight questions. On Questions 1, 2, 3, and 5 Eric demonstrated working carefully. On Questions 3 and 5 Eric demonstrated not guessing. On Question 1 Eric demonstrated being active. Being careful and breaking the problem into pieces were not demonstrated during this pre-test. Eric's overall score was three correct out of seven attempts (this participant ran out of time to complete the eighth question). On the pre-test, there were no marks other than his name and his answers. There were zero instances of out-loud positive statements. Eric used the entire time available to complete the test.

On the first BLP question Eric did not demonstrate any problem solver qualities. However, on Questions 2, 3, and 4 Eric demonstrated being careful and avoiding guessing. On Questions 2 and 3 Eric demonstrated being active. Positive attitude, and breaking the problem into pieces were not demonstrated on this BLP. Eric correctly answered three out of four questions on this BLP. On the second BLP Eric demonstrated working carefully and not guessing on all four questions. Positive attitude and breaking the problem into pieces were not demonstrated on this BLP. Eric correctly answered two out of four questions correctly. Eric's performance on the third BLP was identical to his performance on the second. On the fourth BLP

Eric demonstrated working carefully and not guessing on questions one and two. On question three Eric demonstrated being active. No qualities were demonstrated for question four. Positive attitude and breaking the problem into pieces were not demonstrated on this BLP. Eric correctly answered zero out of four problems on this BLP.

Upon review of all of Eric's BLPs it was noticed that the majority of questions missed included graphs. A fifth BLP was formed that had no graphs or graphing questions. On the fifth BLP Eric demonstrated all problem solver qualities on Questions 1, 2, and 4. Eric demonstrated working carefully, not guessing, and being active on Question 3. Eric correctly answered three out of four questions on this BLP.

During the post-test, Eric demonstrated all problem solver qualities on Questions 1, 3, 4, 5, and 6. On Question 2 Eric demonstrated all qualities except for a positive attitude. Eric correctly answered four out of six problems attempted (this participant ran out of time for the last two questions).

On all three class probe tests Eric answered all questions correctly. This included the questions that included graphs and material previously unable to complete. Having a trained active listener to work with was enough to increase Eric's problem solving performance.

Figure 8 displays the cumulative occurrences of Kitty's problem solver qualities (top graph) and Kitty's accuracy of solving problems (bottom graph). During Kitty's first pre-test, she demonstrated working carefully on Questions 1, 2, 3, and 4. Kitty demonstrated not guessing on Questions 1, 3, and 4. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this pre-test. Her overall score on the pre-test was three correct out of seven attempts. There were no marks on the test other than her name and the answers. While taking the test, there were zero instances of out-loud positive statements. During her second

attempt on the pre-test Kitty demonstrated working carefully, and not guessing on Questions 1, 3, and 4. Kitty demonstrated working carefully on Question 2. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this pre-test. Kitty's overall score was three correct out of six attempts. There were zero instances of out-loud positive statements and she used the entire time available. On the pre-test, there no marks other than her name and answers.

On Kitty's first BLP, she demonstrated working carefully and not guessing on Questions 1 and 2. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this BLP. She did not answer Questions 3 and 4, but used the entire time available. Kitty's overall score was one correct out of two attempts. On Kitty's second BLP she demonstrated working carefully, breaking the problem into pieces, not guessing, and being active on Question 4. Positive attitude and being active were not demonstrated during this BLP. Her overall score was one correct out of four attempts. On the third BLP Kitty demonstrated working carefully and not guessing on Questions 1, 2, and 3. Kitty demonstrated a positive attitude on question one. Breaking the problem into pieces was not demonstrated during this BLP. Kitty's overall score was three correct out of four attempts. Due to time constraints, a fourth BLP could not be administered.

On the post-test, Kitty demonstrated working carefully and not guessing on Questions 1, 2, 3, 4, 5, and 6. Kitty demonstrated a positive attitude on Question 1, and being active with the problem on Question 4. Kitty's overall score was six correct out of six attempted. Kitty asked to be finished without solving the last two problems. Both of those problems involved reading and making graphs.

During all three class probe tests Kitty demonstrated all problem solver qualities. Kitty correctly answered every question on all three probe tests.

Figure 9 displays the cumulative occurrences of Charles' problem solver qualities (top graph) and Charles' accuracy of solving problems (bottom graph). It is important to note that Charles was never able to finish TAPS training. He made it through the fourth training phase. Despite not completing TAPS training, the post-test and class probe tests were still administered to Charles before leaving.

On the pre-test, Charles demonstrated working carefully and not guessing on Question 1. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this pre-test. After working awhile on question one the participant circled answers for all questions and turned in his test. Charles' overall score was one correct out of seven attempts. On Charles' second attempt he demonstrated working carefully and not guessing on Question 1. Charles also demonstrated working carefully on Question 2. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this pre-test. Charles' overall score was one correct out of seven attempts.

For the first BLP, Charles demonstrated working carefully, not guessing, and being active on Questions 2 and 3. Charles demonstrated working carefully and not guessing on Question 4. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this BLP. Charles' overall score was one correct out of four attempts. On Charles' second BLP he demonstrated working carefully on Questions 1 and 4. Charles also demonstrated not guessing on Question 4. Positive attitude, breaking the problem into pieces, and being active were not demonstrated during this BLP. Charles' overall score was one correct out of four attempts. Due to time constraints, we were not able to administer the final two BLPs.

On the post-test, Charles demonstrated breaking the problem into parts, not guessing, and being active on Question 1. He also demonstrated being active on Questions 3, 4, and 5. Positive attitude was not demonstrated during this post-test. Charles' overall score was one correct out of seven attempts.

On the first class probe Charles demonstrated all problem solver qualities on all ten questions, except a positive attitude. Charles correctly answered nine out of ten questions on this probe. On the second class probe he demonstrated a positive attitude and being active on Question 1, positive attitude on Question 2, all problem solver qualities on Question 3, positive attitude and being active on Question 4, and positive attitude on Question 5. Charles' overall score was one correct out of six attempts. On the third class probe Charles demonstrated all problem solver qualities on all five questions. Charles' overall score was zero correct out of five attempts. The first three probes were conducted with a staff member not trained in TAPS. Two more class probes were conducted with a TAPS trained staff member. On the first class probe with a TAPS trained active listener, Charles demonstrated all problem solver qualities on all three questions. Charles' overall score was three correct out of three attempts. On the second class probe with a TAPS trained staff member, Charles demonstrated all problem solver qualities on all three questions. Charles' overall score was three correct out of three attempts.

DISCUSSION

This study supports previous research that suggests that teaching TAPS can improve problem solving. It also extends the generality of previous research on TAPS to special education students. During the pre-test, participants occasionally exhibited three of the problem solving repertoires: being careful, being active, and avoids guessing. The participants may have learned these skills from previous teachers. However, none of the participants displayed the other two problem solving repertoires during the pre-test: breaking the problem into parts and having a positive attitude. All participants had low accuracy when solving problems on the pre-test.

After the initial five phases of TAPS training, participants were able to identify good and bad examples of each repertoire while watching others solve problems. They also regularly exhibited the three problem solving repertoires that were present during the pre-test (being careful, being active, and avoids guessing) when solving problems themselves. However, this initial training was not sufficient for students to begin utilizing the remaining two repertoires while solving problems, and their accuracy when solving problems remained low.

For all participants, the remaining two repertoires were first demonstrated during the TAPS guided practice. During these sessions, participants worked on problems and received feedback from the teacher. This helped participants learn to identify the TAPS repertoires while solving problems. As a result, the final two qualities appeared (breaking the problem into parts and having a positive attitude) and participants' accuracy when solving problems increased. The results of this study suggest that the TAPS guided practice with feedback may be a vital component for teaching students when and how to utilize the TAPS repertoires.

All three participants demonstrated every TAPS repertoire while working with an active listener. However, some of these repertoires disappeared during the post-test. The post-test

differed significantly from the practice sessions because students had to work alone, without the help of an active listener. For one participant, Kitty, this did not seem to make a difference. Even though Kitty did not display breaking the problem into parts, being active, and having a positive attitude, she accurately solved all the problems on the post-test. This suggests she may have been performing these qualities silently. Eric, on the other hand, continued to exhibit all five of the problem solver qualities on the post-test. However, his accuracy decreased, and he only correctly solved four of the six problems. Charles did not display breaking the problem into parts or having a positive attitude during the post-test, and, he only got one problem correct out of seven problems. For Eric and Charles, the removal of an active listener had a negative effect on their post-test accuracy. These results suggest that having an active listener present was essential for these participants to fully utilize the TAPS repertoires. Later, when paired again with an active listener, they both engaged again in the TAPS problem solving repertoires and their accuracy increased. It is worth noting that after the post-test, Charles was first paired with a listener who had not been trained in TAPS. His accuracy remained low until he was paired with a TAPS trained active listener. This suggests that the problem solver repertoire was under the control of the active listener, not the problem. It seems that students must learn how to be their own listeners in order to solve problems on their own. This shows the importance of the active listening repertoire to the problem solving process. Future research should examine the measurement and teaching of the active listening repertoire.

This study demonstrates that the TAPS repertoires can be taught easily and efficiently to students with special needs. As a result of learning TAPS, students' accuracy increased when solving problems. Although further research needs to be conducted regarding how to implement

TAPS in classrooms that teach students with special needs, it appears to be a promising technology for teaching problem solving skills.

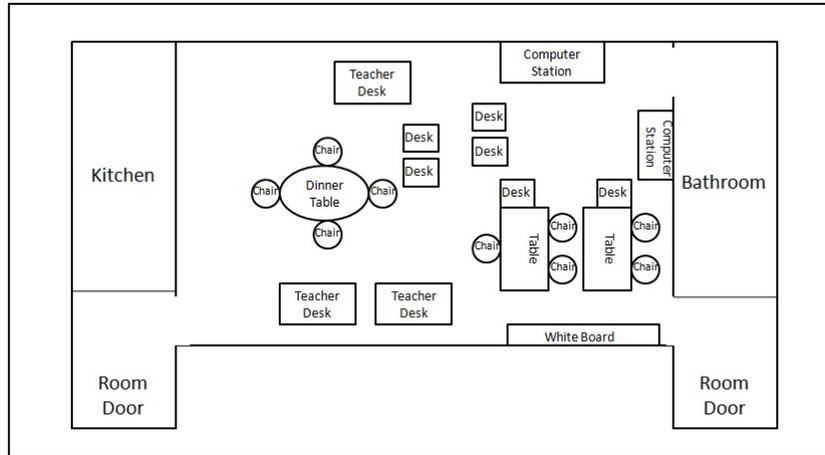


Figure 1. The classroom layout where the study was carried out.

| | | | | | |
|----------------|----------|------------------|------------------|-----------------|-----------------|
| Eric | Pre-Test | TAPS Training | Final- Probe | Class- Probe | |
| Kitty | Pre-Test | Pre-Test | TAPS Training | Final- Probe | Class- Probe |
| Charles | Pre-Test | Pre-Test | TAPS Training | Final- Probe | Class- Probe |

Figure 2. Experimental design used in this study.

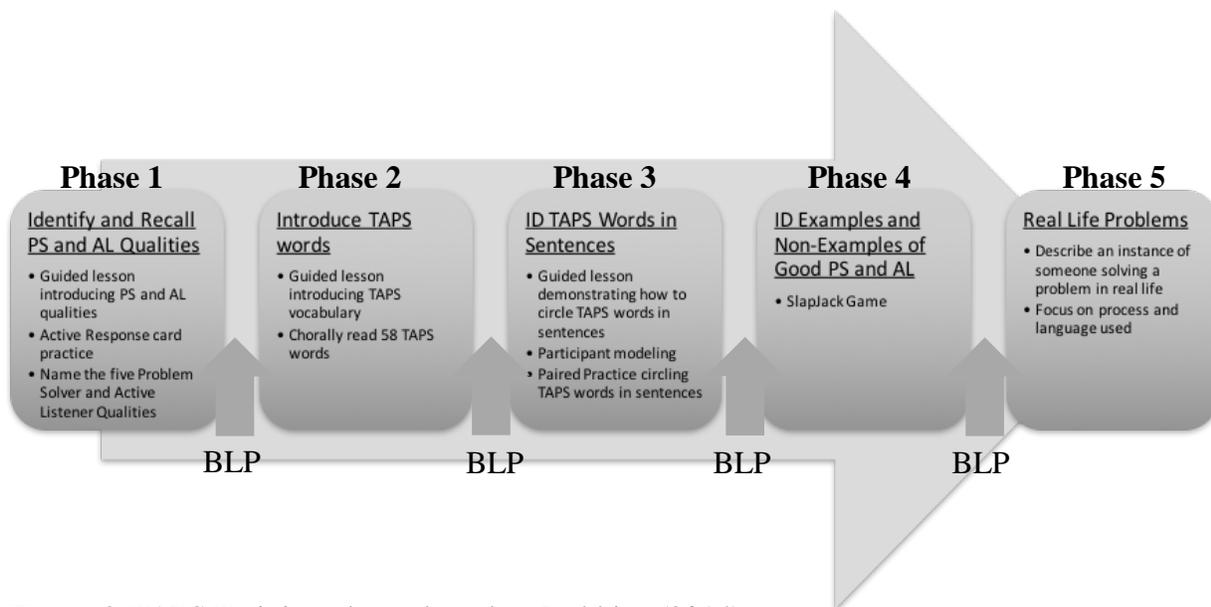


Figure 3. TAPS Training phases based on Robbins (2014).

| Eric Active Listeners | | | | |
|-----------------------|---------|---------|--------|---------|
| Demo 1 | Demo 2 | Demo 3 | Demo 4 | Demo 5 |
| Teacher | Teacher | Charles | Kitty | Charles |

Figure 4. Eric’s active listeners during TAPS guided practice demonstrations.

| Kitty Active Listeners | | |
|------------------------|--------|---------|
| Demo 1 | Demo 2 | Demo 3 |
| Teacher | Eric | Teacher |

Figure 5. Kitty’s active listeners during TAPS guided practice demonstrations.

| Charles Active Listeners | | | |
|--------------------------|--------|---------|--------|
| Demo 1 | Demo 2 | Demo 3 | Demo 4 |
| Eric | Eric | Teacher | Kitty |

Figure 6. Charles’ active listeners during TAPS guided practice demonstrations.

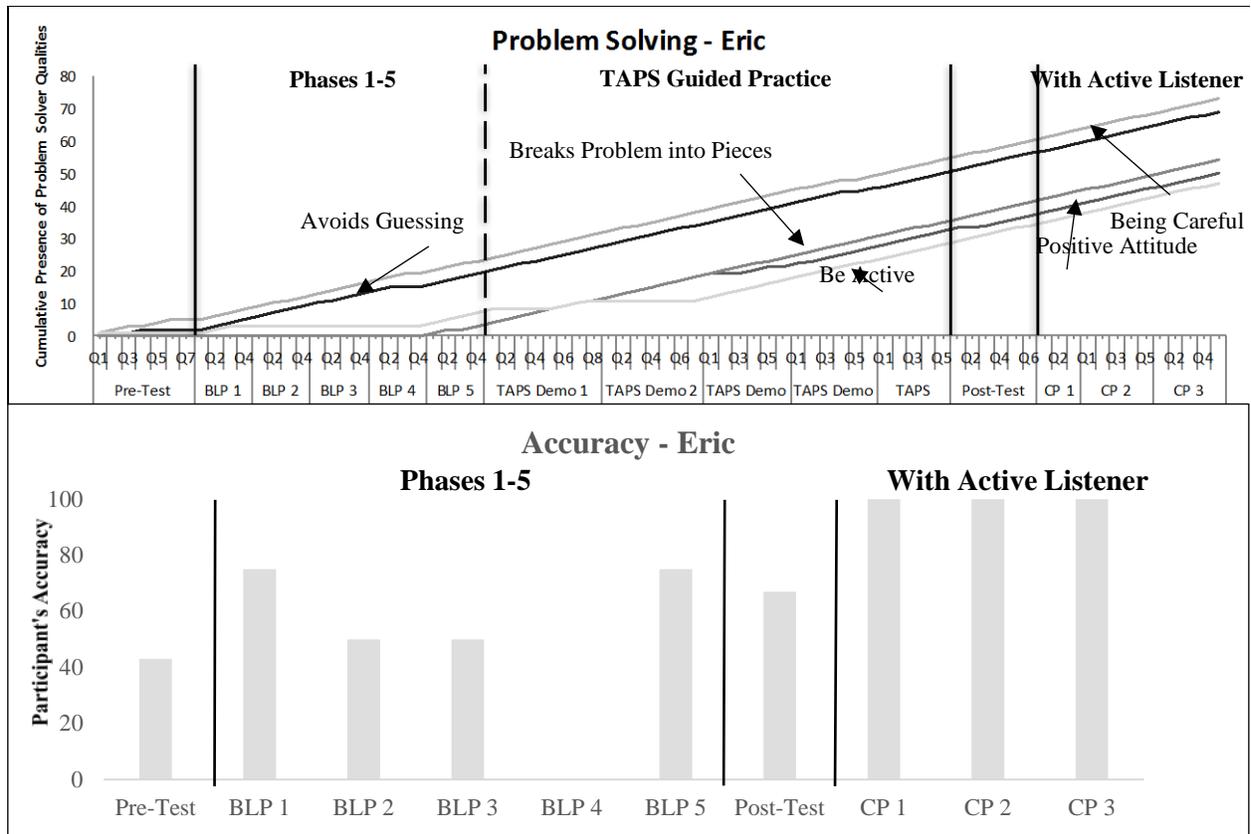


Figure 7. Eric's cumulative occurrence of problem solver qualities (top) and accuracy solving problems (bottom).

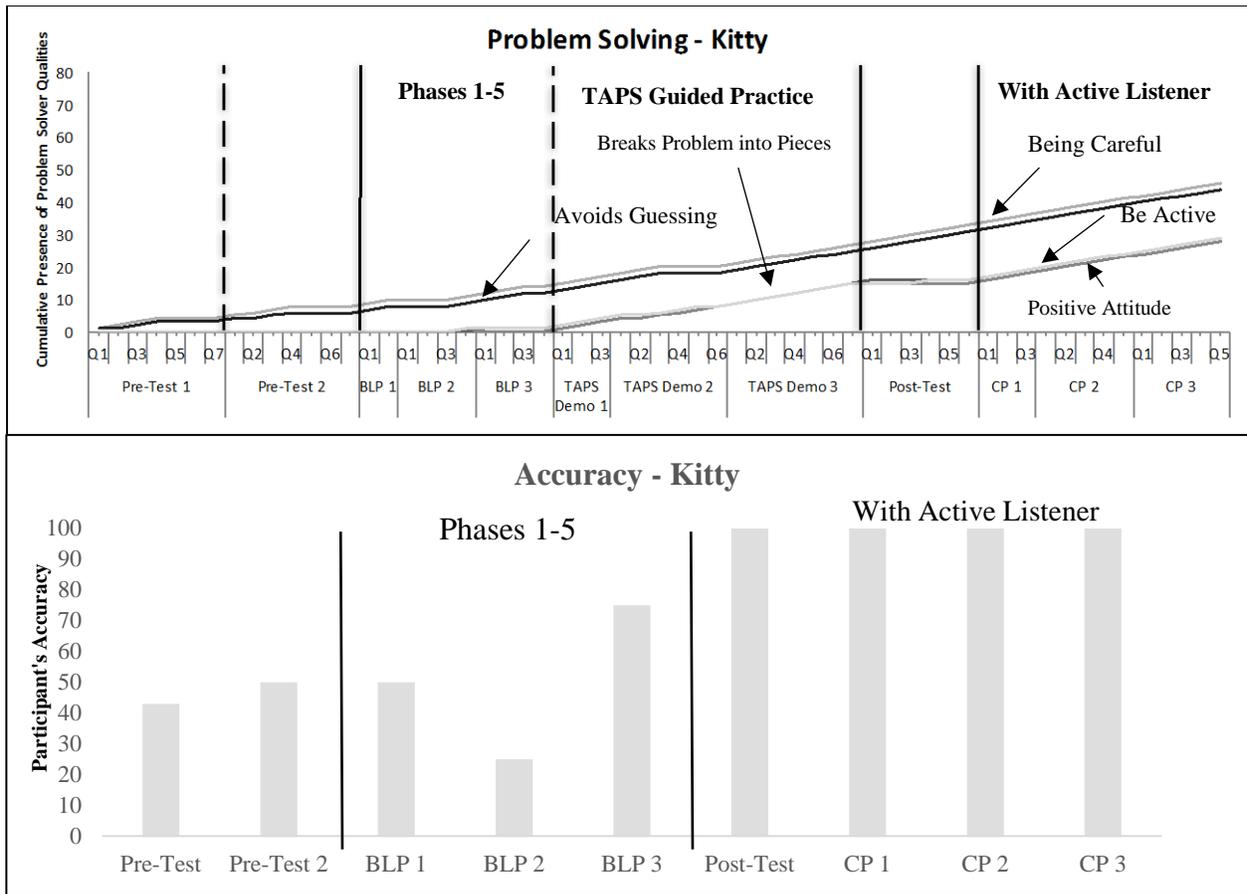


Figure 8. Kitty's cumulative occurrence of problem solver qualities (top) and accuracy solving problems (bottom).

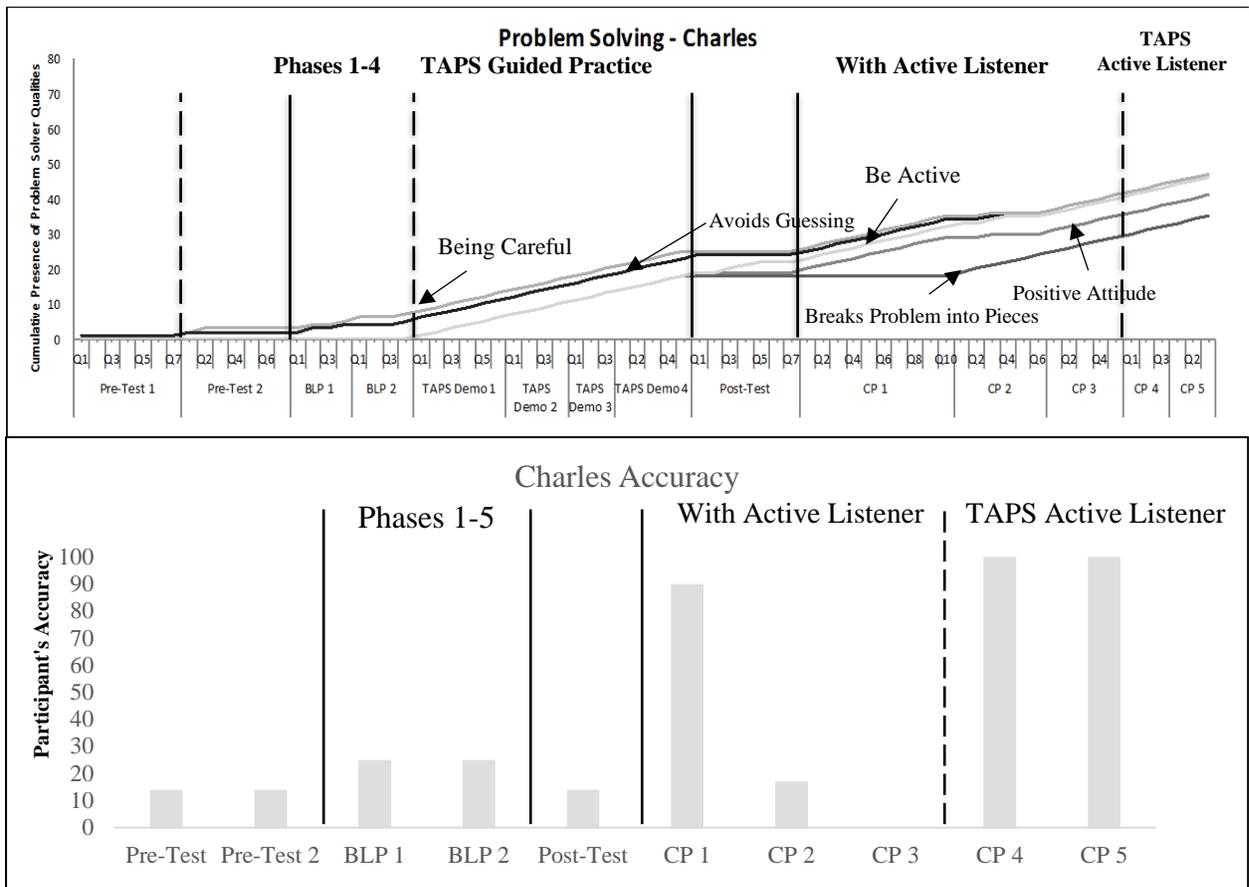


Figure 9. Charles' cumulative occurrence of problem solver qualities (top) and accuracy solving problems (bottom).

APPENDIX A
RECRUITMENT FLYER

2015-2016

Life Skills Class



JOINING US ON
THE JOURNEY
TOWARDS PROBLEM SOLVING
AND HIGH REASONING SKILLS

_____s collaborating
with the University of North Texas to conduct
innovative research in our classroom. Participation
in said research could lead to improve in Problem
Solving and Reasoning Skills.



"Think left and think right
and think low and think high.
Oh, the thinks you can think up
if only you try!"

- Dr. Seuss

For questions
contact Sean Will



Talented5Star.com

APPENDIX B
INFORMED CONSENT

University of North Texas Institutional Review Board
Informed Consent Form

Before agreeing to your child's participation in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study:

Increasing Problem Solving Skills in a Special Education Class through Teaching Reasoning and Active Listening Repertoires

Investigator:

Sean Will, University of North Texas (UNT) Department of Behavior Analysis.

Supervising Investigator:

Jesus Rosales-Ruiz

Purpose of the Study:

You are being asked to allow your child to participate in a research study which involves teaching five problem solving and five active listening skills. These problem solving and active listening skills are intended to increase your child's ability to solve problems, both academic and non-academic.

Study Procedures:

- 1) Students participating in this experiment will be asked to participate in a DIEBLS pre-test in order to identify current reading levels. The entry repertoire for participation in this experiment is a second grade reading level. Students that do not meet these criteria will participate in Headsprout Early Reader Program to build their reading repertoires to a second grade level.
- 2) Students will participate in Talk Aloud Problem Solving training
- 3) We are asking you to give consent for the data from your child's training assessments to be reanalyzed and summarized in order to assess if additional changes occurred. Your child's name will never be associated with any of the data. We will use pseudonyms to describe your child in any publications.

.....
Foreseeable Risks:

No foreseeable risks are involved in this study. Previous clinical and research reports have identified no harm and substantial benefit from participation in the training that was associated with the study and there is no foreseeable harm in completing the questionnaire.

Benefits to the Subjects or Others:

Direct benefits to the subjects may include increased reasoning and problem solving repertoires, the ability to think critically about novel problems encountered inside and outside of school. The results of the study may add directly to the knowledge of other service providers delivering staff training for children with disabilities. This, in turn, may benefit future staff and the children they serve.

Compensation for Participants:

None

Procedures for Maintaining Confidentiality of Research Records:

The results will be delivered to the principal investigator thus being kept completely anonymous. All data will remain coded throughout the study and unidentifiable to anyone outside of the research team.

For trainees consenting to participate in this study, pseudonyms will be assigned to each trainee and those pseudonyms will be used when referring to that participant data. These pseudonyms will be maintained throughout the course of the research. Following the completion of the research study, the files will be kept for a period of three years and then destroyed. Personally identifiable data will not be disclosed to anyone outside the research team. The confidentiality of the participants' personal information will be maintained in any public dissemination, such as appearance in academic journals and/or academic conferences.

Questions about the Study: If you have any questions about the study, you may contact Sean Michael Will at seanmichaelwill@gmail.com or Dr. Jesus Rosales-Ruiz at Jesus.Rosales-Ruiz@unt.edu.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-4643 with any questions regarding the rights of research subjects.

Research Participants' Rights:

Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- Sean Michael Will has explained the study to you and answered all of your questions. You have been told the possible benefits and the potential risks and/or discomforts of the study.
- You understand that you do not have to allow your child to take part in this study, and your refusal to allow your child to participate or your decision to withdraw him/her from the study will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your child's participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as the parent/guardian of a research participant and you voluntarily consent to your child's participation in this study.
- You have been told you will receive a copy of this form.

Printed Name of Parent or Guardian _____

Signature of Parent or Guardian _____

Date _____

For the Student Investigator or Designee:

I certify that I have reviewed the contents of this form with the parent or guardian signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the parent or guardian understood the explanation.

Signature of Student Investigator _____ Date _____

Child Assent Form:

You are being asked to be part of a research project being done by the University of North Texas, Department of Behavior Analysis.

This study involves learning new ways to solve problems. You will be asked to take a test before we begin, and after we're finished. During TAPS training we will practice our new skills on practice problems that will take about 10 minutes.

If you decide to be part of this study, please remember you can stop participating any time you want to.

If you would like to be part of this study, please sign your name below.

Printed Name of Child _____

Signature of Child _____

Date _____

Signature of Student Investigator _____ Date _____

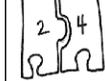
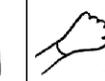
APPENDIX C
TAPS DATA SHEET

Observer: _____

Date: _____

Learn to Reason with TAPS

a Talk Aloud Problem Solving Approach

| | Problem Solver | | | | | Active Listener | | | | | |
|----------------|---|---|---|---|--|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |  |  |  | |
| Problem Solver | Shows a positive attitude | Works carefully | Breaks the problem into parts | Does not guess the final answer; Answers with confidence | Shows the thinking/reasoning process | Checks PS for accuracy | Follows along | Catches partner's errors | Is like a teacher | Encourages partner (warm fuzzy) | |
| 1 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 1 |
| 2 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 2 |
| 3 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 3 |
| 4 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 4 |
| 5 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 5 |
| 6 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 6 |
| 7 | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | yes no& | 7 |

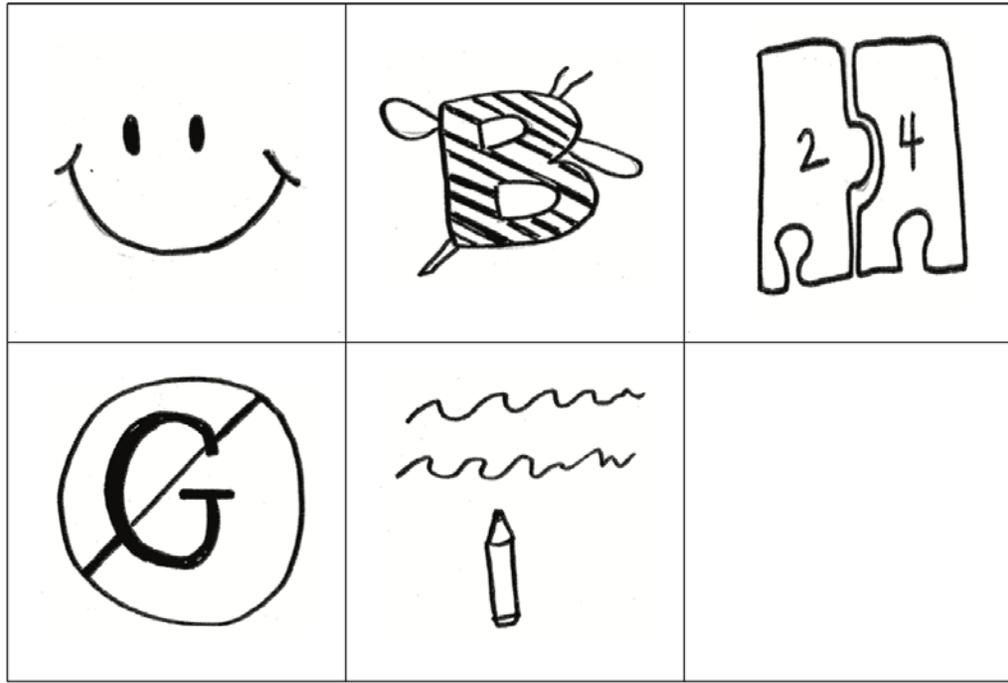
©JK Robbins 2016

APPENDIX D
SLAPJACK DATA SHEET

| Student | Corrects | Incorrects | Pass |
|---------------------------|----------|------------|------|
| Problem Solver | | | |
| Good Attitude | | | |
| Breaks Problem into Parts | | | |
| Avoids Guessing | | | |
| Be Active | | | |
| Be Careful | | | |
| Active Listener | | | |
| Catches Mistakes | | | |
| Like a Teacher | | | |
| Checks Accuracy | | | |
| Stay with Problem Solver | | | |
| Use Encouraging Words | | | |

APPENDIX E
ACTIVE RESPONSE CARDS

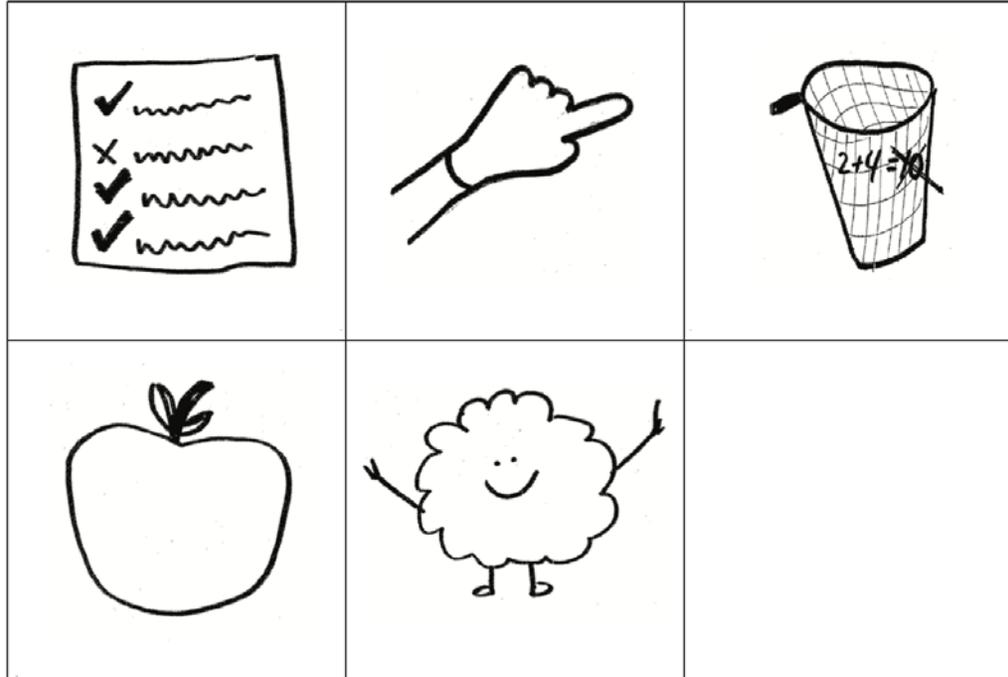
Learn to Reason with TAPS:
a Talk Aloud Problem Solving Approach
Active Response Cards Problem Solver
© JK Robbins 2014



| | | |
|---|---|--|
| <p>Break the problem into parts.</p> <p>©JK Robbins 2014</p> | <p>Be careful.</p> <p>©JK Robbins 2014</p> | <p>Have a positive attitude.</p> <p>©JK Robbins 2014</p> |
| | <p>Be active with the problem.</p> <p>©JK Robbins 2014</p> | <p>Avoid guessing the answer.</p> <p>©JK Robbins 2014</p> |

Learn to Reason with TAPS:
a Talk Aloud Problem Solving Approach

Active Response Cards Active Listener
© JK Robbins 2014



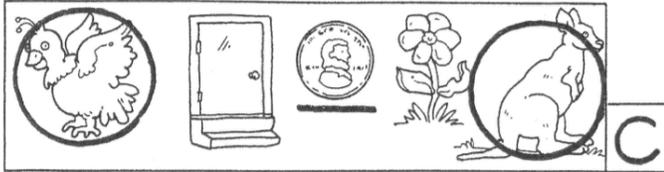
| | | |
|--|---|---|
| <p>Catch mistakes.</p> <p>©JK Robbins 2014</p> | <p>Stay with the Problem Solver.</p> <p>©JK Robbins 2014</p> | <p>Check for accuracy.</p> <p>©JK Robbins 2014</p> |
| | <p>Use encouraging words to keep the Problem Solver working out loud.</p> <p>©JK Robbins 2014</p> | <p>Be like a teacher. Don't give away the correct answer. Lead your partner to the information.</p> <p>©JK Robbins 2014</p> |

APPENDIX F

PRE-TEST, POST-TEST, BLP, AND CBA QUESTION SAMPLES

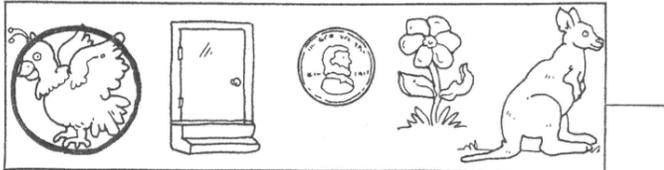
Match each set of directions to the correct box. Write the letter next to the box. The first one is done for you.

1.



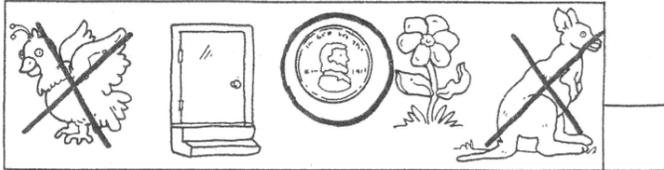
A. Circle the money and cross out the animals.

2.



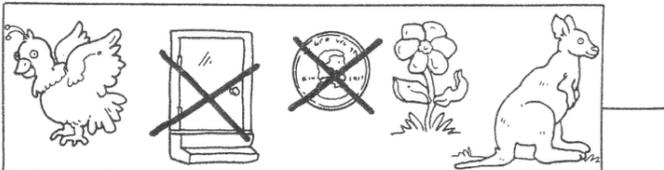
B. Cross out the things that are not alive.

3.



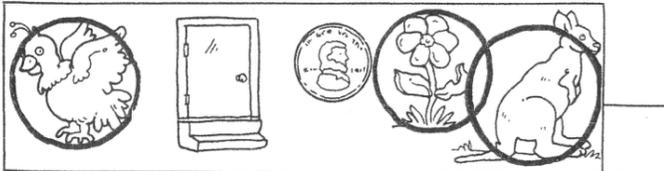
C. Circle the animals and put a line under the money.

4.



D. Circle the things that are alive.

5.



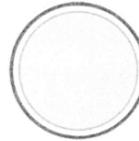
E. Circle the thing that can fly.

Solve the following four analogies by selecting the correct answer and writing the underlined letter in the circle to the right.

1

_____ is to cry as happy is to laugh

eyes sad
glad giggle



2

sky is to _____ as grass is to green

red yellow
white blue



3

dog is to walk as _____ is to swim

cat mouse
fish water



4

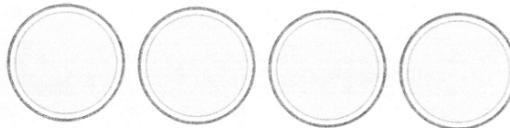
maple is to tree as rose is to _____

garden vase
leaf flower



Unscramble the four letters from the circles above and find the answer to the following analogy challenge!

See is to sea as here is to



Solve the analogies by writing the letter to the correct picture in the circle.

1

 is to  as  is to 

A  B  C  D 

2

 is to  as  is to 

A  B  C  D 

3

 is to  as  is to 

A  B  C  D 

4

 is to  as  is to 

A  B  C  D 

Name _____

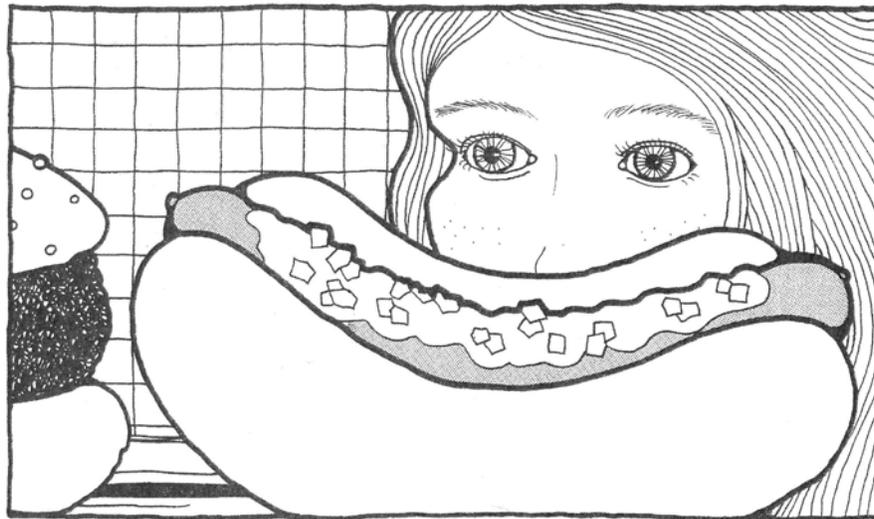
Cafeteria Choices

Lollie, Jay, Dominick and Kristi got in line at the cafeteria at the same time. Each one chose a different lunch. The lunches they chose were a slice of pizza, a taco, a sloppy Joe and a hot dog. Eat through the clues to discover what each student chose for lunch.

Clues

1. Jay is in the same class as the girl who chose a sloppy Joe and the girl who picked the hot dog.
2. Dominick told the others that he was allergic to pizza.
3. Lollie hates hot dogs.

| | pizza | taco | sloppy Joe | hot dog |
|----------|-------|------|------------|---------|
| Lollie | | | | |
| Jay | | | | |
| Dominick | | | | |
| Kristi | | | | |



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