Effects of the TIP Strategy on Problem Solving Skills of Young Adults with Intellectual Disability

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Abstract: The purpose of the study was to investigate the effectiveness of teaching a three-step cognitive strategy (TIP) using the schema broadening procedures on functional mathematical problem solving skills of young adults with intellectual disability (ID). We randomly assigned 14 learners with ID to the control and experimental group before the intervention. An instructor delivered a series of 12 lessons to students in the experimental group following the procedures developed by the researchers. After the intervention, students in the experimental group outperformed the control group with regard to their ability to (a) use the strategy to calculate tip and bill amounts and (b) transfer the use of the strategy to solve novel problems in the same schema. In addition, five students in the experimental group successfully generalized the use of the TIP strategy in a real-life situation one week after the intervention.

Self-determination, the ability to express personal preference, make choices, set goals, and take responsibilities, is one of the primary educational outcomes for individuals with intellectual disability (ID; Carter, Lane, Pierson, & Stang, 2008). Self-determination is directly related to outcomes in the areas of employment, independent living, and participation in the schools and community (Patton et al., 1996). One set of skills that is essential for individuals to achieve self-determination is the ability to manage one’s own money including spending, budgeting, and investing (Browder & Grasso, 1999). However, these skills are particularly challenging for individuals with ID and often become a major obstacle for these individuals in their journey to reach independence (Halpern, Close, & Nelson, 1986; Stancliffe & Lakin, 2007). Results of the National Longitudinal Transition Study-2 (Wagner, Newman, Cameto, Garza, & Levine, 2005) indicate that in comparison to their nondisabled peers, very few young adults with ID had a savings account (33.9%), a checking account (1.7%), or a credit card of their own (1.6%). As a result of their limited money management skills, only 28.6% of the adults with ID are expected to reach financial independence. They are also very likely to experience financial difficulties in their lives.

One reason why individuals with ID have limited money management skills is that they have significant skill deficits in all aspects of the mathematics including facts, concepts, and procedures (Browder & Grasso, 1999; Geary, 1994; Mercer & Miller, 1992). For example, Wagner and colleagues (2003) found that 68% of the secondary learners with ID were more than five grade levels behind their nondisabled peers in mathematics. In addition, when facing real-life money management activities, learners with ID do not utilize effective strategies to solve the problems. More specifically, learners with ID have difficulties (a) identifying relevant information, (b) translating problems to mathematical equations, and (c) solving problems using basic mathematic computation skills (Erez & Peled, 2001; Jitendra et al., 1998; Montague,
Mathematical skill deficits, when coupled with a lack of effective strategies to solve real-life money management problems, often have a negative impact on individuals’ abilities to manage their own money and to reach financial autonomy (Maughan, Collishaw, & Pickles, 1999). Therefore, effective money management intervention for individuals with ID should address both mathematical skills deficits and the use of strategies to solve real-life problems.

Unfortunately, typical mathematics instruction for individuals with ID only emphasizes basic numeracy skills (i.e., counting, matching, discrimination) and computation fluency without teaching the skills required to solve problems in real life (e.g., Mattingly & Bott, 1990; Miller, Hall, & Heward, 1995; Morin & Miller, 1998). Similarly, traditional money management instruction for learners with ID almost exclusively focuses on teaching purchasing skills using interventions designed to bypass more complex mathematical skills (e.g., Browder, Snell, & Wildonger, 1988; Colyer & Collins, 1996; Denny & Test, 1995). Although effective, the utility of these interventions is hardly transferrable to contexts other than grocery stores, fast food restaurants, and vending machines. Systematic literature reviews on money management instruction for individuals with ID highlighted the needs for additional research on how to teach more complex money management activities that require the use of multistep mathematical problem solving skills (Browder & Grasso, 1999; Xin, Grasso, Dipipi-Hoy, & Jitendra, 2005). Research also revealed that a fundamental reason for the lack of research in this area is educators’ low expectation for learners with ID because they incorrectly assume that high level multistep problem solving skills are beyond the cognitive capabilities of all students with ID (Baroody, 1996; Butler, Miller, Lee, & Pierce, 2001; Hord & Bouck, 2012; Parmar, Cawley, & Miller, 1994). However, recent development in academic interventions for learners with ID has shown that these learners are capable of learning more complex academic skills than previously assumed (Browder, Trela, Gibbs, Wakeman, & Harris, 2007). Given the potential impact of mathematical problem solving skills on individuals’ ability to achieve financial autonomy and self-determination, it is imperative that educators teach learners with ID this set of skills using evidence-based instruction.

One research-based mathematical problem solving intervention is cognitive strategy instruction. Using teacher-directed explicit instruction procedures, cognitive strategy instruction teaches students the processes required to perform tasks with the awareness of planning, executing, and monitoring (Reid & Lienemann, 2006). A typical cognitive strategy development instructional model contains six stages of learning including (a) developing and activating background knowledge, (b) discussing the strategy, (c) modeling the strategy, (d) memorizing the strategy, (e) practicing the strategy with teacher prompts, and (f) conducting independent practice. Utilizing this instruction model, educators successfully taught school age children with learning disabilities how to solve mathematical problem using different strategies (Jitendra & Hoff, 1996; Jitendra & Xin, 1997; Montague & Dietz, 2009; Montague, Enders, & Dietz, 2011; Xin & Jitendra, 1999; Xin, Jitendra, & Deatline-Buchman, 2005). Although the impact of cognitive strategy instruction on the money management skills of young adults with ID is relatively unknown some research evidence suggests that young adults with ID may benefit from this intervention and learn effective strategies to solve multistep mathematical problems (Chung & Tam, 2005; Erez & Peled, 2001). Recently, Hua, Morgan, Kaldenberg, and Goo (2012) successfully taught a group of young adults with ID a cognitive strategy designed to solve problems requiring tip and bill calculation. Using TIP as a first-letter mnemonic device, the strategy contains three steps including (a) Take a look at the total bill and enter it on the calculator; (b) Identify the tip by multiplying the total by 15%; and (c) Plus the total and find out how much to pay. Based on the cognitive instructional developmental model (Deshler, Ellis, & Lenz, 1996), Hua and colleagues developed and taught a series of six lessons to five adult learners with ID. The results of the study indicated that all five students learned to calculate the tip and bill amounts using the TIP strategy. However, some learners in the study had difficulties generalizing the strategy to novel problems requiring similar solutions (e.g., tax).
Difficulties with skill generalization are characteristics of learners with ID. They either have a limited awareness of the contexts in which the strategy can be applied or incorrectly apply the strategy to problems that require different solutions (Baroody, 1996). Cooper and Sweller (1987) conceptualized this difficulty as a skill deficit related to learners’ knowledge of the schema; a schema is a group of problems that require a similar solution (Gick & Holyoak, 1983). With adequate knowledge of the schema, learners are able to first determine if a novel problem is within the boundaries of a familiar schema and then solve the problem using the corresponding strategy. However, when learners have extremely narrow schema boundaries or do not recognize the connectedness of the novel and the familiar problems, they are not likely to choose the right strategy and transfer their knowledge to solve novel problems. In order to address this skill deficit, Cooper and Sweller recommended that educators incorporate instructional procedures that may trigger and broaden the awareness of the problem solving schema of students with learning difficulties. One example of this type of instructional procedure is schema-broadening instruction. Based on the schema construction theory, the schema-broadening instruction explicitly teaches both structural features of the schema and features that may change the problems without altering the solution (Powell, 2011). For example, after learners acquire the solution of one schema teachers can systematically teach learners how novel word problems with irrelevant features (e.g., different situations, different format, and different contexts) are connected to the familiar schema and then prompt students to solve these problems using the same solution. Utilizing this schema-broadening instructional procedures, researchers effectively improved performance of students with LD on tasks that required them to transfer the knowledge of a problem solution to novel problems in the same schema (Fuchs & Fuchs, 2005; Fuchs, Fuchs, Finelli, Courey, & Hamlett, 2004; Fuchs, Fuchs, Hamlett, & Appleton, 2002).

Given the effectiveness of the schema-broadening intervention on knowledge transfer, incorporating this intervention as a component of the TIP strategy seems to be a promising extension of the intervention and may consequently enhance learners’ ability to apply the strategy to solve a variety of unfamiliar real-life problems that require similar solutions. Therefore, the purpose of this study was to extend the utility of the TIP strategy instruction by explicitly teaching generalization using schema-broadening procedures and examine its effects on the mathematic problem solving skills of young adults with ID. Specifically, we asked:

1. Will young adults with ID acquire and apply the TIP strategy to calculate tip and total bill?
2. Will these learners transfer the TIP strategy to solve problems in the same schema?
3. Will these learners generalize the TIP strategy in a real-life situation where tip calculation is required?

Method

Participants and Setting

Students enrolled in a certificate program for young adults with learning and intellectual disabilities at a Midwest university participated in the study. The postsecondary education program provides an integrated college experience with academic coursework, student life, career development and community life. The program’s academic coordinator suggested that many of their students needed help with functional math skills in calculating tips and total bills while out in the community.

In order to participate in the study, students must have met the following inclusion criteria used by Hua and colleagues (2012). First, students had to be able to use a calculator to complete the mathematical computation tasks accurately. Second, students must have scored below 50% on the pretest containing word problems requiring them to calculate the tip and total bill amounts. Fourteen students with ID met the inclusion criteria and participated in the study. With a total number of six females (42.9%) and eight males (57.1%), the participants ranged in age from 19 to 22 years with a mean of 19 years, 11 months (SD = 1.08 years). All of the participants were Caucasian, with six (42.9%) from rural areas, one (7.1%)
from an urban area, and seven (50%) from suburban areas. We administered the Woodcock Johnson Achievement III (WJIII; Woodcock, McGrew, & Mather, 2001) before the study and the median Broad Math standard score of the participants was 68 (range, 36–89).

We used a pre- and posttest with control group design and randomly assigned the 14 participants to either the experimental or control group; each group had seven students. This design allowed us to investigate the effects of the intervention while controlling for threats to internal validity (Campbell & Stanley, 1966). We conducted an independent $t$-test before the intervention and did not find statistically significant differences between the two groups with regard to their pretest ($t_{[12]} = 1.000, p = .337$) and WJIII Broad Math standard scores ($t_{[12]} = 1.350, p = .202$).

We trained an instructor who had 18 years of special education teaching experience to implement the TIP strategy. Students in the experimental group received the strategy instruction during the scheduled class time (i.e., Tuesday and Thursday); each lesson lasted 45 minutes with a total duration of 6 weeks. We arranged a writing class for students in the control group to take at the time of the study.

**Materials**

We incorporated the schema-broadening procedures (Fuchs & Fuchs, 2005) in the TIP strategy instruction and developed a series of 12 scripted lesson plans. Each scripted lesson included teacher wording, problem examples, student worksheets, and overhead transparencies. We created two equivalent probes as the pre- and posttest of experiment. Each probe contained 18 novel problems (i.e., problems we did not use during the instruction). Similar to the measures used by Fuchs and Fuchs, we included four types of problems on the probes designed to measure students’ ability to use and transfer the strategy (see Table 1 for an example of each type of problem). Each type of problems varied with regard to its distance required for the students to transfer the use of the strategy from the context in which the TIP strategy was initially taught. Target items ($n = 5$) had the shortest transfer distance and required the students to calculate tip and bill

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<th>Problem</th>
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<td><strong>Target</strong></td>
<td>Mike had a dinner at a restaurant and the bill was $35.63. He paid the bill with additional 15% for the tip.</td>
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<tr>
<td><strong>Immediate Transfer</strong></td>
<td>(a) How much was the tip? (b) How much did he pay in total? The price for a can of soda is $2.99 and the sales tax is 6%. (a) How much is tax? (b) How much total will you pay for the soda?</td>
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<tr>
<td><strong>Near Transfer</strong></td>
<td>You want to add 15% tip. (a) How much is the tip? (b) How much is the total you will pay?</td>
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<tr>
<td><strong>Far Transfer</strong></td>
<td>The book is on sale for 20% off. The price for the book you want to buy is $20.00. (a) How much money will you save from the sales? (b) How much is the book now?</td>
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<td><strong>Near Transfer</strong></td>
<td><img src="Image" alt="Receipt Image" /></td>
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<td>The book is on sale for 20% off. The price for the book you want to buy is $20.00. (a) How much money will you save from the sales? (b) How much is the book now?</td>
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amounts using different percentage values with different cover stories (e.g., pizza delivery, taxi fare, restaurant). Immediate transfer items \((n = 5)\), instead of relying on narratives to state the problem and relevant information, required the students to calculate tip and bill amounts using the relevant information presented on a copy of the receipt. Near transfer items \((n = 4)\) included problems that could be solved using identical procedures as the TIP strategy but in a different context (e.g., salary increase, tax). Items that had the longest transfer distance were the far transfer items \((n = 4)\). These items required the students to solve problems by modifying the procedures of the TIP strategy (e.g., find out the sales price using percentage values).

**General Procedure**

The teacher delivered the TIP strategy following the scripted lesson plans developed by the researchers. Each lesson began with a teacher statement of the daily objective and a brief review of the previous lesson. During the instruction, the teacher first modeled skills followed by student practice with teacher prompts. The teacher then gradually faded the prompts and had the students practice the skills independently. At the conclusion of each lesson, the teacher provided an overview of the lesson and previewed the next lesson. The teacher also delivered the lessons using critical presentation techniques that are found to contribute to student learning including eliciting frequent unison responses from the students, providing immediate feedback, and maintaining a brisk pace of the instruction (Brophy & Good, 1986).

**TIP Strategy and Schema-Broadening Procedures**

The TIP strategy instruction consisted of seven stages, including (a) pretest and make commitment, (b) describe the strategy, (c) model the strategy, (d) verbal elaboration and rehearsal, (e) guided practice and feedback, (f) independent practice, and (g) generalization. We embedded the schema-broadening procedures within the last stage of strategy instruction to facilitate skill generalization.

**Stage 1 (1 Lesson).** The purpose of the first lesson was to discuss the pretest results and to provide a rationale for learning the TIP strategy. During the lesson, the teacher elicited student responses through scenarios on how knowledge of appropriate tipping would help them live more independently. This discussion helped the students buy into the rationale of why this skill is important for their future. The instructor committed to teach the strategy through effective instruction and in return, the students wrote a commitment to learn the strategy through spending time and effort required to acquire this skill.

**Stage 2 (1 Lesson).** The purpose of this lesson was to describe the TIP strategy. The teacher and students first discussed when and where this strategy should be used and when it would not be appropriate through different scenarios. Following the discussion, the teacher described the rationale and procedures of each step. The teacher also activated and assessed students’ prior knowledge of the key concepts and procedures by eliciting frequent responses from the students (e.g., “Where can you find a bill’s total?”). At the end of the lesson, the teacher asked the students to make their own cue card containing the TIP strategy mnemonic.

**Stage 3 (1 Lesson).** The purpose of this lesson was to model the TIP strategy using “think aloud”. During modeling, the teacher verbalized her thought process required to use the strategy. She used different statements to (a) define the problem (e.g., “I need to find out how much I need to pay.”), (b) give a rationale to use the TIP strategy (e.g., “The TIP strategy will help me calculate tip and bill amounts.”), and (c) describe each step of the strategy (e.g., “The first step is take a look at the total bill.”). The teacher also emphasized the metacognitive process in her demonstration including self-copying (e.g., “It is a word problem, but I can use the TIP strategy to help me figure out the answer.”), self-evaluation (e.g., “Let me check the answer and make sure it is correct.”), and self-reinforcement (e.g., “I did a good job with this problem.”). During this stage of learning, we limited the examples to identically worded problems that had different cover stories (i.e., low transfer demand problems). Each cover story represented a situation that required a tip and bill calculation using a 15% tip rate (e.g., restaurant, food delivery, and cab fare). At the end of the
lesson the teacher assured the students that they would get plenty of practice using the new strategy in the coming sessions.

Stage 4 (1 Lesson). The purpose of this lesson was to ensure that the students understood each step of the strategy and committed the strategy to memory. The teacher first checked students understanding of each step by having them explain in their own words what they would do for each step of the strategy. The teacher then used a “rapid fire practice” to help students memorize each step of the strategy (Deshler et al., 1996). During the rapid fire practice, the teacher elicited frequent unison responses from the students to state the three steps of the strategy while gradually removing words from each step until only initial letters of the three steps were visible. Following the rapid fire practice, the students practiced memorization of the mnemonic with a partner. At the end of the lesson, the teacher formatively assessed each student’s knowledge of the strategy using a checklist. During the assessment, the students had to orally explain the purpose of the TIP strategy and state each step of the strategy in order without referring to the cue card. Students received additional opportunities to practice memorization with a partner until they reached the 100% accuracy mastery criterion on the assessment.

Stage 5 (4 Lessons). The purpose of this stage of learning was to provide students with the opportunities to practice the use of the TIP strategy with teacher prompts. Similar to the problems used in stage 2, the students worked on problems with low transfer demand that required them to calculate tip and bill amounts using 15%. After collaborative group practice between the teacher and students, the teacher gave the students their first opportunity to apply the strategy independently. The students worked on the problems independently while the teacher monitored and provided feedback.

Stage 6 (2 Lessons). The purpose of this stage was to ensure mastery of the TIP strategy. After a quick verbal review of the purpose and steps of TIP, students worked on the word problems requiring tip calculation independently. The teacher continued to monitor student work and provide individual feedback. At the end of the lesson, the teacher collected and scored student work. The teacher analyzed student errors and provided specific feedback to individuals at the beginning of subsequent lessons.

Stage 7 (2 Lessons). The purpose of this stage of learning was to broaden the TIP schema to contexts other than tipping using 15%. The teacher explicitly taught the students that the TIP strategy could be applied to a variety of problems that may look different. Similar to the procedures used by Fuchs and Fuchs (2005), the teacher included examples that varied by irrelevant features including different percentage values, different format (e.g., present the problem on a receipt), and context (e.g., find price after tax). The teacher first modeled the strategy generalization followed by student guided practice. The teacher also encouraged the students to come up with their own scenarios where the TIP strategy could be applied. The whole class discussed each scenario and solved the problem using the TIP strategy together.

Dependent Measures and Data Collection

We administered a pretest before the intervention and a posttest immediately following the intervention to the participants in both the experimental and control group. At the beginning of the assessment, the teacher asked the students to complete the worksheets with the following statement: “This is not a test or an assignment. It will not count towards your grades. Try your best to answer these questions. Remember to write down how you get the answers. If you don’t know how to answer the question, make an ‘X’ on it and go to the next one. You have 15 minutes to work on these problems. It is okay if you don’t finish all the questions in 15 minutes. If you finish early, raise your hand and I will collect your worksheets. If you need a calculator, please raise your hand and I will give you one.” At the end of the 15 minutes, the teacher stopped the assessment and collected students’ answer sheets. We used total number of questions answered correctly as a dependent measure of the study. Each problem asked two questions related to the two steps of the TIP strategy (e.g., tip and total bill) and the students received credit for every question
answer correctly. Total number of questions on each probe was 36.

We also assessed students' functional use of the TIP strategy in a real-life context one week after completion of the intervention. To administer the functional probe, we invited all of the participants to attend a party where they had the opportunity to order food and drinks individually. At the end of the party, we gave each student a bill for the food and drinks they ordered and asked them to find out how much they needed to pay without giving additional instruction. The students received credit for correctly calculated tip and bill's total on the receipt.

Reliability and Procedural Integrity

We developed a procedural checklist based on each scripted lesson plan. A graduate student who had two years of special education teaching experience observed each lesson and conducted the procedural integrity checks using the checklists. The procedural integrity was 100% across all sessions.

After the teacher graded student responses on the pretest, posttest, and generalization probe, a graduate student who was not involved in data collection conducted reliability checks. We calculated the reliability data using the point-by-point agreement procedure and the inter-rater reliability on the pre-, posttest, and functional probe was 99% (range, 92–100%), 100%, and 100%.

Results

Table 2 presents the means and standard deviations of total number of questions answered correctly on the pre- and posttest by students in both the experimental and control group. None of the students in the control group answered any of the questions correctly on both pre- and posttest. Students in the experimental group answered an average of 0.00 questions correctly on the items that assessed target, immediate, and far transfer skills; one student answered two questions correctly on the immediate transfer items, which in turn resulted in an average of 0.29 questions correct for the group. After the intervention, students in the experimental group answered an average of 9.00, 8.71, 6.00, and 4.00 questions correctly on the target, immediate, near, and far transfer items, respectively. We compared the gain scores between the two groups using independent t-tests and found that students in the experimental group made significantly more gains with large effect sizes (Cohen, 1988) than students in the control group on target (t[12] = 18.445, p = .000, d = 9.86), immediate (t[12] = 13.779, p = .000, d = 7.36), near (t[12] = 7.626, p = .000, d = 4.08), and far transfer items (t[12] = 7.483, p = .000, d = 4.01). With regard to the functional use of the TIP strategy, we found five students (71.42%) in the experimental group correctly calculated the tip and total amount on their bill. None of the students in the control group correctly calculated the tip and bill’s total on the receipt.

Discussion

Learning how to tip and solve problems using percentage value is an important and useful
money management skill for young adults with ID. In order to use this money management skill, learners must have an effective strategy to first identify the relevant information and recognize the connectedness of the problem with a schema they know and then solve the problem using the pertinent mathematical skills (e.g., choose the correct operation, retrieve the procedural knowledge, and use basic math facts for computation). However, learners with ID often have difficulties with all aspects of this problem solving process. Before the intervention, students in both the experimental and control group performed similarly on the pretest with regard to the total number of word problems solved correctly. Our error analysis of the pretest indicated that initially all of the participants in the study did not have knowledge of an effective strategy to solve problems requiring the use of percentage values. It is clear that these learners were not likely to correctly calculate tip and bill amounts and solve problems requiring similar solutions without instruction. In order to remediate this skill difficulty, we implemented an intervention designed to address both the cognitive and metacognitive learning needs of individuals with ID. In comparison to the initial investigation by Hua and colleagues (2012), we extended the intervention in several ways. First, we incorporated the procedures designed to trigger and broaden the awareness of the schema in the instruction to promote students’ transfer of the strategy. Second, we examined the learners’ functional use of the strategy as a money management skill in a real-life situation. Third, we used a rigorous experimental design that enhanced our ability to ascertain the causal relationship between the intervention and outcome. In the study, students with ID not only acquired the multistep strategy necessary for tip calculation but also transferred this knowledge to a variety of novel problems belonging to the same schema. In addition, they successfully generalized the use of the TIP strategy in a real-life context. Therefore, the results of the study indicate young adults with ID can benefit from cognitive strategy instruction and schema-broadening procedures to improve their money management and mathematical problem solving skills.

We found both the strategy and the instruction contributed to the effectiveness of the intervention. The TIP strategy has characteristics of an effective strategy with regard to its content, design, and utility (Ellis & Lenz, 1987). First, the content of the TIP strategy addressed the gap between the demand of a money management skill and the mathematical problem solving skill deficits of learners with ID. Second, the mnemonic device (TIP) facilitated memorization and utilization of the strategy in real-life contexts. Third, the strategy contained an efficient solution to solve problems in a variety of contexts. An effective strategy alone, however, does not guarantee learners with ID will successfully acquire and use it. Research evidence suggests that learners with ID often lack the metacognitive skills needed to effectively utilize strategies (Allardice & Ginsburg, 1983; Cherkes-Julkowski, 1985). Therefore, we explicitly modeled the metacognitive processes required for successful application of the TIP strategy including planning, executing, and monitoring (Reid & Lienemann, 2006). During modeling, the teacher emphasized self-coping, self-evaluation, and self-reinforcement. She also asked the students to “think aloud” while working on the problems during the guided practice. Verbalizing their thought process triggered the use of a metacognitive process and also provided the teacher with opportunities to monitor learners’ thought processes while using the strategy (Jitendra & Xin, 1997; Montague et al., 2011). As a result of the instruction, students in the experimental group acquired the TIP strategy and improved their accuracy on the target items that required tip and bill calculation.

In order to expand the utility of the TIP strategy, we incorporated schema-broadening instruction as a component of the intervention so that students learned how to apply the strategy to a variety of real-life problems in the same schema. During initial stages of instruction, we limited the instructional examples to only low transfer demand problems (i.e., identically worded problems with a different cover story). This allowed the learners to recognize how the problems were connected without devoting too much of their cognitive resources to irrelevant features and procedural details (Fuchs & Fuchs, 2003). Once the learners acquired the critical structural features of
the TIP schema and reached procedural fluency, we systematically increased the transfer distance using novel problems that varied by irrelevant features (e.g., different format, different question, and different context), thus expanding the schema boundaries and facilitating the generalization of the strategy use. After receiving the schema-broadening instruction, students in the experimental group improved their accuracy on the items that required strategy transfer. Similar to findings from previous studies, results of this study also suggest that as the teacher made problems progressively less similar to those used for instruction it became increasingly more difficult for the students to identify the connectedness of the problems with the schema they were familiar with and their accuracy decreased consequently (Cooper & Sweller, 1987; Fuchs & Fuchs, 2005). Far transfer problems were particularly challenging for the students. In order to solve this type of problem correctly, students had to modify the procedures of the TIP strategy. For example, when working on the problems that asked for sales prices, all of the students in the experimental group correctly identified savings using the discount rate. However, instead of using subtraction, they all applied the identical TIP solution to the problems without modification. Adapting and modifying the strategy to solve new problems is the highest level in the learning hierarchy and requires conceptual understanding of the problem and solution (Haring & Eaton, 1978).

In the study, we only emphasized the procedural knowledge and metacognitive processes required to solve the problems without focusing on the conceptual learning of the schema. Research evidence suggests that educators may facilitate strategy generalization and adaptation when cognitive strategy instruction involves teaching the underlying concept of the schema (Jitendra, Burgess, & Gajria, 2011; Montague et al., 2011; Xin, Jitendra, et al., 2005). For example, teachers can explicitly teach the rationale why tip should be added to the bill to help students understand the concepts of the TIP schema. Therefore, future researchers should consider incorporating procedures designed to enhance the conceptual understanding of the schema and examine its effects on learners’ ability to adapt the strategy in response to the demands of new problems.

The efficiency of the intervention is another feature worth noting. In comparison to typical interventions for learners with ID that often require one-on-one instruction (Alwell & Cobb, 2009; Spooner, Knight, Browder, & Smith, 2012), we delivered the instruction to a group of seven students without compromising the effectiveness of the instruction. Learners’ attentiveness and their opportunities to respond are two challenges for teachers when delivering instruction to groups (Brophy & Good, 1986). In this study, the teacher maintained a higher level of academic engagement and student responding by eliciting frequent unison responses that involved both oral (e.g., “Class, what is the first step of strategy?”) and observable behavioral responses (e.g., “Put your finger on problem number one.”). Through carefully worded questions and clear hand signals, the teacher elicited frequent responses and ensured that all students were attentive and on task. This instruction delivery technique also provided the students with opportunities to retrieve and practice new skills, thus increasing skill retention and fluency (Archer & Hughes, 2010).

**Limitations and Future Research**

The results of the study must be interpreted within the context of its limitations. First, researchers found that the most challenging aspect of the cognitive strategy learning process for individuals with ID was the maintenance and generalization of the skills to functional activities within the community and their place of employment (Baroody, 1996; Butler et al., 2001; Erez & Peled, 2001; Hord & Bouck, 2012). In this study, we had only one opportunity to assess the learners’ strategy use in a real-life situation one week after the intervention. Also, we did not assess if the learners maintained the strategy after the intervention. Future research needs to investigate the effects of this intervention on long term maintenance and functional use of the strategy in real-life situations (Browder & Cooper-Duffy, 2003; Deshler et al., 1996).

Second, the fourteen participants in the study represented a sample with diverse learning histories and needs. Researchers have
found that learners’ characteristics including chronological age and IQ scores may have a significant impact on the development of mathematical problem solving skills (Conners, 1990; Facon & Facon-Bollengier, 1999). For example, two students in the experimental group were less responsive to the intervention and scored one standard deviations below the means of the experimental group. These two students also failed to correctly calculate the tip and bill amounts on the functional probe. It is possible that these learners need more intensive instruction and additional practice in order to master the strategy. Therefore, we need further empirical evidence to determine if learners’ characteristics (e.g., age, disability, IQ) have an impact on the effectiveness of the intervention.

Practical Implication

Baer, Wolf, and Risley (1987) pointed out that an intervention cannot be effective if it is socially invalid. Several features we included in the study increased the social validity of the intervention with regard to its outcome and acceptability. First, we taught a cognitive strategy that young adults with ID can use to solve real-life money management problems. The participants of the study not only acquired the strategy necessary for tip calculation but also transferred this knowledge to novel problems that belong to the same schema. Therefore, the outcome of the intervention was meaningful and may have a direct impact on the quality of individuals’ lives. Second, we made sure that the intervention was acceptable and sustainable by recruiting the instructor from the program to deliver the TIP strategy during her regularly scheduled class time. In order to ensure the quality of intervention, we trained the instructor at the beginning of the study and provided additional feedback based on our classroom observation. The instructor, in return, kept us apprised of student progress and acceptability of the intervention. At the end of the study, the instructor reported that she felt confident teaching the TIP strategy and that she plans to continue to use this intervention as part of the money management curriculum for other students in the program.

Conclusion

Teaching students with ID how to solve real-life problems using mathematical skills may result in independent functioning in the areas of daily living, places of employment, and participation in education (Alwell & Cobb, 2009). Results of this study suggest that the TIP strategy instruction and schema-broadening procedures may improve the mathematical problem solving skills of young adults with ID. The intervention may also result in generalization of the strategy use to real-life situations and in novel contexts that require similar solution. This study adds to an increasing body of literature demonstrating that learners with ID are capable of learning complex academic skills using evidence-based systematic instruction.

References


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