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# Teaching Money Computation Skills to High School Students with Mild Intellectual Disabilities via the *TouchMath©* Program: A Multi-Sensory Approach

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*Abstract: This study investigated the effects of the TouchMath© program (Bullock, Pierce, & McClellan, 1989) to teach students with mild intellectual disabilities to subtract 3-digit money computational problems with regrouping. Three students with mild intellectual disabilities in high school received instruction in a special education mathematics self-contained classroom. A multiple-probe across participants design (Alberto & Troutman, 2009) was used to evaluate the effectiveness of the TouchMath© program using the "touch-points" strategy to facilitate the student's mathematics performance. The results revealed the TouchMath© program improved all three of the students' ability to subtract 3-digit mathematics operations using money applications; however, maintenance results were mixed, as the students exhibited difficulty with maintaining the necessary skills once the intervention was withdrawn. Limitations, recommendations for classroom teachers and future research directions are presented.*

With the growing trend of providing proven, *scientifically-validated* practices in the classroom, teaching students' mathematics instruction at the secondary-level, especially those with intellectual disabilities, can be a challenging and often overwhelming task. With recent mandates from federal policies like, the No Child Left Behind Act of 2001 (NCLB, 2001) and the Individuals with Disabilities Education Improvement Act (IDEA, 2004), schools are now mandated that *all* students have equal access to the general education academic curriculum and national and state standards (National Council of Teachers of Mathematics, 2000; U. S. Department of Education, 2007). Thus, an increasing number of students with mild intellectual disabilities are now receiving instruction and being placed into general education classrooms where they are not only expected to succeed in the classroom, but also on high-stakes assessments such as the Georgia End of Course Test (EOCT) and the Georgia High School Graduation Test (GHSGT). These new classroom rigors include moving away from functional academics and replacing them with more traditional academic skills. While this is a positive move toward allowing all students regardless of their disability the opportunity to graduate with a high school diploma and prepare them to attend further educational and occupational prospects, this does not allow students with mild intellectual disabilities the chance to learn the essential life skills (e.g., money computation) that are crucial for their survival in the community as independent members of society.

Students with mild intellectual disabilities often exhibit deficits in basic mathematics instruction, especially in the area of money computation (e.g., purchasing skills), which has been well documented (Browder & Grasso, 1999; Browder, Spooner, Ahlgrim-Delzell, Harris, & Wakeman, 2008; Butler, Miller, Kit-hung, & Pierce, 2001; Jitendra & Xin, 1997; Kroesbergen & Van Luit, 2003; Mastropieri, Bakken, & Scruggs, 1991; Miller, Butler, & Lee, 1998; Swanson & Jerman, 2006, Xin & Jitendra, 1999). In 2000, the *National Council of Teachers of Mathematics* (NCTM, 2000) stated in a comprehensive report five main components of mathematics instruction standards

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that all students are required to achieve, one of which focuses *explicitly* on the ability to measure attributes of objects such as time and *money applications*, which is commonly problematic for a large number of students with mild intellectual disabilities. Fortunately, a growing research-base of new and innovative interventions, like the *TouchMath©* program, has been developing in the literature and has shown some promising results to be effective in increasing students with and without disabilities mathematics performance.

The *TouchMath©* program (Bullock et al., 1989), a multi-sensory "dot-notation" system, previously employed by Kramer and Krug (1973) was used to teach mathematics skills to students with disabilities. The *TouchMath©* program uses "dot-notations" often referred to as "touch-points" either with one dot, for numbers 1 to 5, or a dot-notation with a circle around them, to indicate two or double touch-points to assist students with and without disabilities with basic counting and computation skills. The *TouchMath©* program using the touch-points strategy, has been shown in previous research to be effective for students with mathematical disabilities in basic mathematics instruction (e.g., adding single, double-digit mathematics problems with and without regrouping) at the *elementary* level for students with specific learning disabilities and moderate intellectual disabilities (Scott, 1993; Simon & Hanrahan, 2004), autism spectrum disorders (Cihak & Foust, 2008), and more recently, at the *middle* school level including students with autism spectrum disorders and moderate intellectual disabilities (Fletcher, Boon, & Cihak, 2010). However, *no studies* to date have attempted to explore the effectiveness of the *TouchMath©* program, using money computation skills, with students with mild intellectual disabilities in a high school classroom setting.

Therefore, the purpose of this study was to examine the effects of the *TouchMath©* program on the acquisition of subtracting 3-digit money computational problems with regrouping for three students with mild intellectual disabilities in a high school special education self-contained classroom. Prior research on the efficacy of the *TouchMath©* program has focused *only* on students with specific learning disabilities, moderate intellectual disabilities, and autism spectrum disorders at the elementary and middle school grade levels, and has *not* addressed the benefits of such a strategy for students with mild intellectual disabilities at the high school level. Although previous studies have investigated the use of the touch-points strategy to teach basic addition using single and double-digit mathematics problems; *no studies* have explored the benefits of the touch-points strategy on money applications.

### *Research Questions*

Thus, the two main research questions posed were: (a) What are the effects of the *TouchMath©* program on the mathematics performance of solving subtraction 3-digit money computational problems with regrouping for students with mild intellectual disabilities at the high school grade level? And (b) What are the students, teachers, and parents perceptions of the *TouchMath©* program to improving students with mild intellectual disabilities mathematics performance?

## Method

### *Participants*

Three students with mild intellectual disabilities, two of which had a dual-diagnosis of autism as well, from the same special education high school self-contained classroom participated in the study. The students' ages ranged from 14 to 16 years-old, with a mean of 14.75 and intellectual quotients (IQ) scores varied from 61 to 64, with a mean of 63. All of the students were classified with a disability based on the county, state, and federal criteria, which indicated having below average intellectual ability, deficits in adaptive behavior scores, which both negatively affected their academic performance. Demographic and educational information is depicted in Table 1. All of the students received special education services since entering high school where they were in a self-contained special education classroom setting for three block periods a day and participated in only one general education course elective. The students were taught all of their academic subjects including mathematics instruction in the same self-contained

**TABLE 1**

**Student Demographic Information**

| | *Trent* | *Michael* | *Alex* |
|---|---|---|---|
| Chronological Age | 15–0 | 14–11 | 16–1 |
| Grade | 9th | 9th | 10th |
| Sex | Male | Male | Male |
| IQ* | 64 | 61 | 64 |
| Adaptive Behavior Score Composite** | 83 | 54 | 71 |
| Math Composite*** (Grade Equivalent) | 5.1 | 4.2 | 2.8 |
| Primary Eligibility | Mild Intellectual Disabilities/Autism | Mild Intellectual Disabilities | Mild Intellectual Disabilities/Asperger's Syndrome |

* *WISC-III COG = Wechsler Intelligence Scale for Children (3rd ed.) by D. Wechsler. Copyright 1991 by Psychological Corp, San Antonio, TX.*

** *ABAS-II = Adaptive Behavior Assessment System (2nd ed.) by P. Harrison & T. Oakland. Copyright 2003 by Psychological Corp, San Antonio, TX.*

*** *MBA = Mini-Battery of Achievement by R. Woodcock, K. McGrew, & J. Werder. Copyright 1994 by Riverside Publishing, Chicago, IL.*

classroom from the same teacher for all three block periods. Finally, all three students scored well-below grade level in mathematics, based on the *Woodcock-McGrew-Werder Mini-Battery of Achievement* (MBA; 1994) test results. Students were selected based on their grade-level, special education classification and mathematical ability. All of the students were unable to properly and accurately subtract numerical or monetary values without a calculator. The classroom instructor had previously taught the students to use calculators to determine purchase price in order to facilitate accuracy and fluency in the classroom and community-based setting.

*Trent.* Trent was a ninth grader and was 15 years, 10 months old at the outset of the study. Trent had received special education services for ten years for a mild intellectual disability and autism. Placement was supported with a Full Scale IQ score of 64 from the *WISC-III* (Wechsler, 1991) and the *ABAS-II* (Harrison & Oakland, 2003), with a 72 conceptual score; 75 social score; 91 practical score, and a general adaptive composite score of 83. Trent's IEP (Individualized Educational Plan) goals covered several academic and life skill areas, as he had a mathematics academic goal of becoming more proficient in basic mathematics skills. His teacher said that he is consistently willing to work hard to complete his assignments and complies with directions from the classroom teacher and paraprofessionals.

*Michael.* Michael entered his first year of high school as a ninth grader during the study at 14 years, 11 months old and turned 15 within the study's span. He struggles with all academic subjects as evident by his instructors' observations during the daily education sessions and receives one to four instructions daily for his academics. Michael has received special education services since his entrance into the school system in self-contained classrooms for students with mild intellectual disabilities. According to the *WISC-III* (Wechsler, 1991) Michael had a Full Scale IQ score of 61, with a 53 conceptual score; 70 social score; 53 practical score, and a general adaptive composite score of 54. The results from the *ABAS-II* (Harrison & Oakland, 2003) instrument determined Michael lacked adaptive behavior skills and met criterion for classification for a mild intellectual disability. Increasing basic mathematics skills was one of his academic (IEP) goals. His teacher stated that he is cooperative during instruction and puts forth much effort towards his classroom work.

*Alex.* Alex was a tenth grade student being served in the same self-contained special education classroom as Trent and Michael. He was 16 years, 1 month at the beginning of the study and has received special education services for thirteen years with an eligibility of a mild intellectual disability and Asperger's Syndrome. Alex's placement was determined by a *WISC-III* (Wechsler, 1991) Full Scale IQ score of 64 and on the *ABAS-II* (Harrison & Oakland, 2003) he had a 70 conceptual score, 77 social score, 75 practical score, and a general adaptive composite score of 71. He had two money mathematics skills goals on his (IEP), which included adding and subtracting two and three-digit mathematics problems without a calculator and to write checks, make deposits, and balance a checkbook. He had demonstrated a lack of restraint and cooperation with teachers in the past, but has not shown these behaviors since entering high school, as his teachers have stated that he has been very obliging and receptive to instruction.

### *Setting and Arrangements*

The public high school consisted of approximately 1,500 students, with grades nine through twelfth, and was located in a southeastern region of the United States. The county school system population was considered low-income, with a low socio-economic status (SES) with manufacturing as the major employer in the area. Data collection, training, and intervention procedures were conducted in that same self-contained special education mathematics classroom. The classroom dimensions were 3 m × 6.5 m and the room consisted of 12 student desks and two teacher desks. The teacher desks faced the student desks located to the side of the student desks and immediately in front of one teacher desk, was a podium. The students were instructed at a distance of 1 meter, facing the teacher, and two student desks were directly in front of the teacher. The *TouchMath©* poster displaying the touch-points for the numbers 1 to 9 was placed on the wall between the student and teacher desks as a reminder and visual cue during the training and intervention phases. No other students were in the classroom during the block period and all phases of the study.

### *Materials*

The *TouchMath©* program (Bullock et al., 1989) was the intervention utilized during the intervention phase to teach students to subtract 3-digit money computational problems with regrouping. The researcher and classroom teacher collected the data for all phases of the study. The researcher and classroom teacher were trained to use the *TouchMath©* program via the teacher training DVD and instructional materials, that were sent by the publisher. The *TouchMath©* system is based on the placement of dots (e.g., dot-notations) on numbers (1 to 9). For example, the student would be asked to state the number aloud then the student was expected to count aloud as he made contact on the touch-points; however, for subtraction problems, the students must be able to count backwards from 20. When regrouping, the students were expected to be able to mark through the number borrowed from and then place a 1 next to the previous number and subtract the numbers. *TouchMath©* made a point of ensuring the number borrowed was the same size as the other digits. Worksheets were provided by the publisher that the researcher and classroom teacher utilized to introduce, instruct, practice, and assess all of the students. The worksheets were designed based on the specific steps previously mentioned above and consisted of examples on how to count forward and add with and without regrouping. A poster with the touch-points for each of the numbers 1 to 9 was posted on the wall in the classroom. In addition, mini-posters were provided to the students and laminated on their desktop as a reference, while learning the touch-points strategy (see Figure 1 for an example of the mini-posters).

### *Assessment Materials*

Researcher developed worksheets with the same font and size as the publisher's were employed as the probe during the intervention and maintenance phases (see Figure 2 for an example of the worksheets). The measures served as permanent products to collect data. These worksheets consisted of 10 subtraction 3-digit money computational problems with regrouping. All probes consisted of different

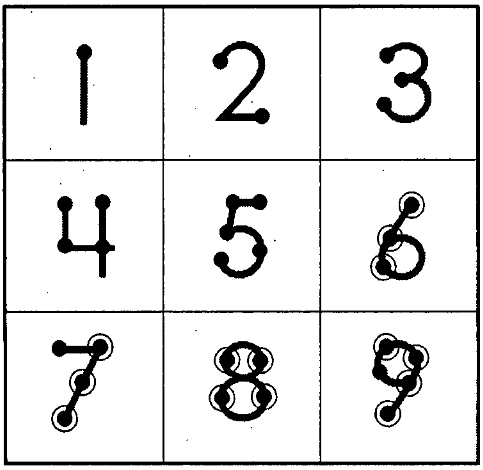


**Figure 1. Example of the mini-poster that was provided to the students and laminated on their desktop as a reference, while learning the touch-points strategy. TouchMath® TouchPoints. By permission of J. Bullock and Innovative Learning Concepts Inc., Colorado Springs, CO. All rights reserved.**

mathematics problems so the students would not be able to memorize the answers.

*Procedure*

*General procedure.* All instruction, training sessions, observations and probes occurred during the regular school day during the first block period from 8:30–10:00 a.m. There were five sessions per week for ten weeks and each student received instruction in the self-contained special education classroom. The training and intervention sessions lasted in duration from 10 to 15 minutes on the *TouchMath©* procedures to subtract numbers with regrouping and probes were designed to take no longer than 10 to 15 minutes. Maintenance sessions extended long enough to complete the probe (10 to 15 minutes). These sessions were held concurrently with the last three intervention sessions of subsequent student's sessions. The intervention was introduced to subsequent students based on the student reaching criterion, which was established as the students' average score increase to be above 40% of the average baseline score for 80% of the sessions. Baseline stability followed the 80/30 guideline to establish a trend before the intervention was implemented.

Intervention began with identifying each of the numbers (1 to 9) and where the touch-points were located on the numbers. Next, the students were taught how to count the touch-points in a certain order, as described in the publisher's manual. According to the *TouchMath©* procedures, the students are to count aloud during instruction, while learning the touch-points on each of the numbers. In addition, counting backwards was also taught and practiced while utilizing the touch-points strategy. Once these skills had been mastered,

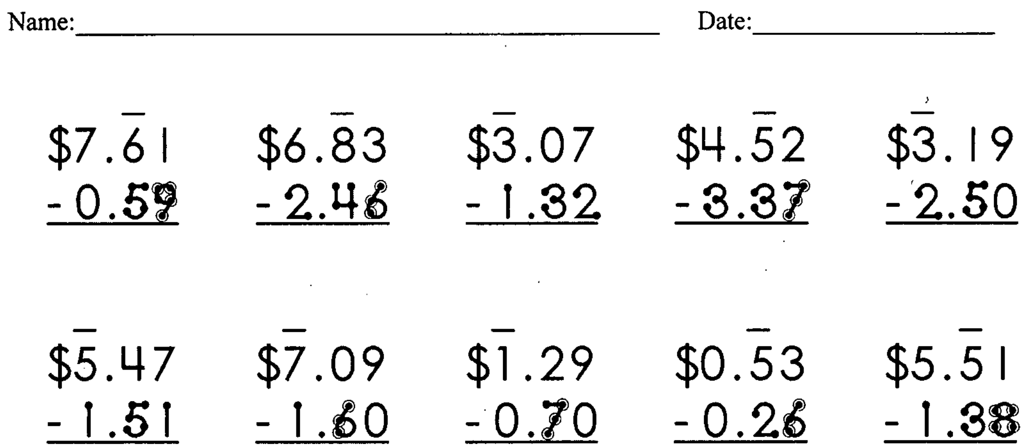


**Figure 2. Example of the subtraction 3-digit money computational problems with regrouping worksheet used during the intervention and maintenance phases.**

the students could move on to actual subtraction problems with regrouping. With the subtraction problems, the students were taught to: (a) state the problem aloud, (b) state the first number aloud, (c) count backwards using the touch-points on the second number (if the student reaches 0 before finishing counting the bottom number, then regroup), (d) mark-out the number borrowed from, write lowered number above on the line, (e) place a 1 next to the number on the right making sure it is the same size, (f) count backwards using the touch-points on the second number, (g) place the difference in the answer blank, and finally (h) repeat the problem aloud with the answer.

*Experimental Procedures*

*Baseline.* Before baseline probes were delivered, prerequisite skills were taught until 100% of the students' mastery was achieved. The student had to be able to learn to count backwards, place the touch-points on the numbers 1 to 9, and count those touch-points in a proper pattern. The first student was administered a minimum of three probes to establish trend stability, which consisted of 10 subtraction 3-digit money computational problems with regrouping *without* the use of the touch-points strategy. Once stability was established, the touch-points intervention began. Subsequent students were probed concurrently with the last three intervention sessions of the previous student. Verbal cues and praise were offered for correct and/or incorrect behaviors.

*Intervention.* First, the *TouchMath©* strategy was introduced to each of the students, which consisted of the instructor modeling how to count the "dot-notations" on each of the numbers 1 to 9 to solve a subtraction problem. The students were then given an opportunity to practice one problem along with the special education teacher using the touch-points strategy. Second, the teacher demonstrated the proper steps and verbal cues to solve a subtraction problem. Afterwards, the student was asked to carry out the task independently as performed by the teacher. During the problem-solving procedures, the instructor provided positive verbal corrective feedback to redirect any operational errors performed by the student. The student then practiced the steps a minimum of five times. Third, the instructor modeled the proper steps of the *TouchMath©* program and verbal cues to solve a subtraction problem. The student was then asked to perform the task as modeled. During the problem-solving procedures, the instructor provided positive verbal corrective feedback to redirect any operational errors performed by the student for the first two practice problems and then was asked to solve a minimum of five problems independently. And finally, in the fourth step, the instructor modeled the proper steps and verbal cues to solve a subtraction problem. The student was then expected to solve 10 3-digit money subtraction computational problems with regrouping using the touch-points intervention *independently.*

*Maintenance.* During the maintenance phase, the students were provided no instruction or visual cues from the *TouchMath©* materials to perform the operational steps to subtract a 3-digit money computational problem with regrouping. After the student had reached criteria for three consecutive days, a minimum of two sessions without instruction lapsed before a maintenance probe was given. These probes consisted of 10 3-digit subtraction problems with regrouping following the same format as those mentioned in the baseline and intervention sessions. Concurrent with subsequent students being presented their last two intervention probes, each previous student was given a minimum of one maintenance probe every five days until the conclusion of the study with the last student. These probes indicated whether the touch-point system could be maintained for other problem sets. Generalization was monitored throughout the study with subtraction problems at the end of each probe. These problems also accompanied maintenance sessions. These three problems, consisting of the same skills addressed during the intervention phase were presented to the students from different stimuli, workbooks and instructor made worksheets. This measure determined if the students could generalize *TouchMath©* techniques and procedures to the same math behaviors from different stimuli.

### *Experimental Design*

This study employed a multiple-probe across participants design (Alberto & Troutman, 2009) to examine the effectiveness of the touch-points strategy to teach students with mild intellectual disabilities to subtract 3-digit money computational problems with regrouping.

### *Reliability*

*Inter-observer agreement.* Inter-observer reliability data was collected across all conditions using a point-by-point agreement formula. The special education teacher's paraprofessional was a second observer and was asked to independently score the probes and evaluate the procedural fidelity measures. The paraprofessional was familiar with the training materials in conjunction with the special education teacher and researcher and was present during a minimum of 20% of the sessions. Inter-observer agreement was calculated based on the point-by-point reliability and calculated by counting the number of agreements between the special education teacher and the paraprofessional and dividing this number by the total number of agreements and disagreements and then multiplied by 100% (Cooper, Heron, & Heward, 2007).

*Procedural reliability.* Procedural reliability was assessed by the special education classroom teacher and paraprofessional in the self-contained special education classroom with a written procedural protocol checklist and was set for a minimum of 90%. Procedural reliability data was collected during the same sessions as the inter-observer agreement data were taken by both teachers on a minimum of 20% of the sessions. A point-by-point agreement formula (Cooper et al., 2007) was again used and was calculated by counting the number of times the special education teacher and/or paraprofessional agreed that a behavior either occurred or did not occur during the sessions. This number was then divided by the total number of agreements and disagreements and multiplied by 100%. Finally, for each of the three students their percentage agreement was recorded for each behavior on the procedural checklist.

### *Social Validity*

A 10-item survey was administered to the students, teachers, and parents to determine the social validity (Wolf, 1978) of the *TouchMath©* program using the touch-points strategy in mathematics instruction. The items in the social validity survey were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The social validity data was collected upon conclusion of the study and the survey was completed by the students and teachers (e.g., special education teacher and paraprofessional) in the high school classroom, while another version of the survey for the parents was mailed to their residence to compete and return back to the special education teacher. The social validity survey consisted of the following items: (1) *TouchMath©* is a beneficial strategy to help me with my subtraction problems; (2) Subtraction is an important skill to have for real-life situations; (3) Subtraction is an important skill to learn before leaving high school; (4) I would recommend this strategy to someone else; (5) I understood the *TouchMath©* strategy and what was expected of me; (6) *TouchMath©* was easy to use; (7) *TouchMath©* was an effective strategy to subtract money values; (8) The target skills are necessary for grade level requirements; (9) The target skills are necessary for classroom requirements; and (10) The target skills are necessary for community-life requirements.

## Results

### *Reliability*

Inter-observer and procedural reliability was collected during 7 (20%) of the 35 sessions. Of the 49 probes graded, two were found to have different scores between the scorers, the special education teacher and paraprofessional. On the two probes, each had one response in conflict between the scorers due to disagreement over identifying a particular digit in the response. The mean percent of agreements for each student was as follows: Trent, 100%; Michael, 93.3%; and Alex, 95%. The mean procedural reliability was 100% for all researcher behaviors across all experimental conditions. Of the observed sessions, 56%

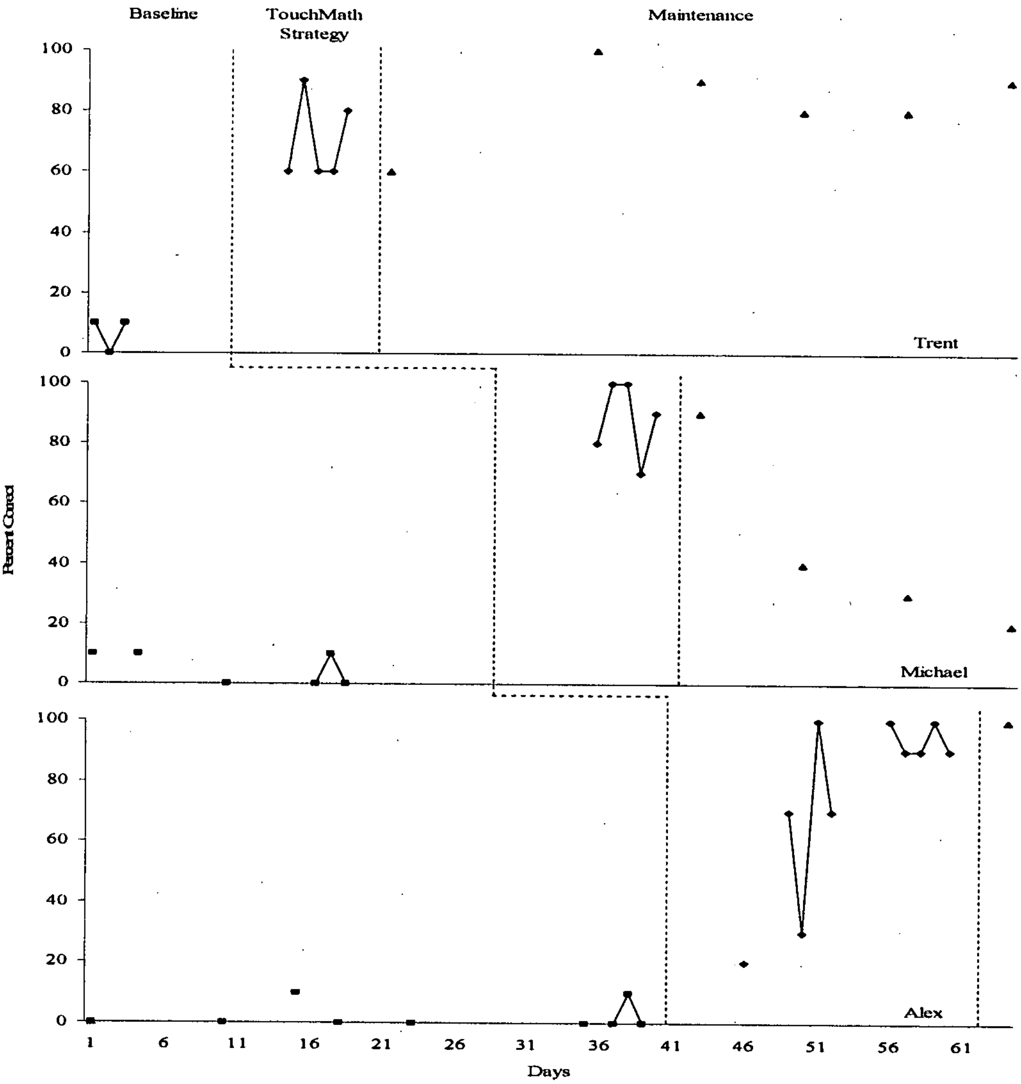


**Figure 3. Percentage of subtraction 3-digit money computational problems with regrouping using the touch-points strategy answered correctly by Trent, Michael, and Alex.**

were conducted during the training phase, while 44% were completed in the probe sessions. The inter-observer agreement was 100%.

*Effectiveness of the Intervention*

Figure 3 illustrates the percentage of correct responses the students received on the subtraction problems with regrouping using money computations during the baseline, intervention, and maintenance phases.

*Trent.* Trent's baseline mean score was 6.66% across all 3 sessions, which demonstrates a stable trend in the data. A substantial immediate positive score increase was observed when the intervention probes were issued, which showed the touch-points strategy was an effective intervention for acquiring subtraction problems with regrouping using money values. The average score across all intervention sessions was 75.55% demonstrating a continual, stable, and maintained acquisition of the target skills set needed to calculate the correct answers, which was a 68.88% increase from the baseline phase. Trent reached criteria within the preset number of sessions, which was established when 80% of the probe scores were 40% higher than the baseline scores. There was no data point overlap observed from the baseline to the intervention phases signifying an immediate positive increase that was maintained throughout the intervention. The trend from the intervention through the maintenance phase was positive and the data points within the trend were reasonably stable. Trent's mean score during intervention was 75.55% and increased to 83% during the maintenance phase, indicating a continual improvement in skill level with additional opportunities to utilize the strategy. There was an 83% overlap between the intervention and maintenance phase, though Trent was able to increase his mean scores during maintenance. This indicates that Trent was able to prolong his ability to solve the subtraction problems with regrouping and, based on his scores during the maintenance phase, improve his scores over time. The intervention strategy was successful initially and in sustaining Trent's ability to solve subtraction problems with regrouping.

*Michael.* Michael's mean score during the baseline phase was 5% indicating that he had established a flat and stable baseline measure. However, Michael's mean score during the intervention phase increased to 88%, which was an 83% increase from the baseline phase. This abrupt level change and 0% overlapping data points from baseline to intervention substantiated that the touch-points intervention strategy was effective for Michael in acquiring the subtraction skills with regrouping. Michael met criteria after only four sessions. There was a level trend after the abrupt level change from the baseline to the intervention phase indicating a consistent calculation skill aptitude. The mean maintenance score for Michael was 45% with a median score of 35%. There was 100% data point overlap from intervention to the maintenance phase. A continual decreasing trend occurred during the maintenance phase ending in a 20% score on the final probe session. Michael did not revert to his previous baseline scores, but further probes would be needed to determine sustained skill retention. The intervention strategy was confirmed to be effective over a relatively short period of time, as further strategy instruction may prove beneficial for Michael's continued success.

*Alex.* Alex's baseline phase extended for 9 sessions, while maintaining a flat and stable trend with a mean score of 2.22%. However, during the intervention phase, Alex demonstrated a positive level change with the first intervention probe session. The second probe score increased significantly from 20% to 70%, then faltering back to 30% causing an unstable level change with the first four sessions. The fifth session established the start of an observable stable level change. Due to beginning unstable scores, Alex required the greatest time to meet criteria. Criteria were met after ten sessions with an average score of 76% and a 90% median score, which was a 73.77% increase from the baseline measures. The touch-points intervention strategy was effective for Alex to subtract 3-digit money problems with regrouping. Between the baseline and intervention phases there was 0% data point overlap, demonstrating a positive level change though five additional sessions were required until stability and criteria were met. There was 100% overlap from intervention to maintenance phase. The mean maintenance score for Michael was 100%. From the beginning of the baseline to the end of the maintenance phase, there was a steady increasing data score trend and overall the touch-points intervention strategy proved to be effective for Alex.

*Social Validity Survey*

In general, the students, teachers, and parents indicated in the social validity survey that the *TouchMath©* program using the touch-points intervention was beneficial. The students stated that the strategy was easy to use and understand and improved their ability to solve subtraction problems with regrouping involving money computations. The teachers reported they appreciated the students' abilities to quickly acquire and successfully follow the number of steps needed to solve the subtraction problems with regrouping. All involved agreed that others would benefit from exposure to the *TouchMath*© program and that it was easy to learn and use in the classroom. The ease of use was also evaluated and the students stated that once they understood the steps and sequence (e.g., counting the dot-notations on the numbers, etc.), the touch-points strategy was a fun, and an easy way to learn how to solve subtraction problems. In addition, all of the groups indicated that they agreed or strongly agreed that the skills gained were necessary for the students to have before leaving high school to prepare them for real-life situations. All involved agreed that the skill was grade appropriate and necessary for classroom requirements. The students reported that they were neutral when considering the skills crucial for grade-level requirements; however, they all agreed that the touch-points strategy was helpful to learning mathematics and would recommend the strategy to their peers. Finally, all of the respondents agreed that money computation skills are an important and critical skill essential for independent living in the community.

**Discussion**

The purpose of this study was to examine the effects of the *TouchMath*© program on the acquisition of subtracting 3-digit money computational problems with regrouping for three students with mild intellectual disabilities in a high school special education self-contained classroom. The findings indicated that the use of the touch-point strategy was effective for all three students in acquiring 3-digit money computational problems with regrouping. Findings from this study not only add to the previous literature base on the *TouchMath*© program, but also provide new insights into applications to teach money computational skills to students at the high school level. As previous studies have suggested, the touch-points strategy procedures have been shown to be effective to increase the mathematics performance for *elementary-age* students with specific learning disabilities, moderate intellectual disabilities, and autism spectrum disorders (Cihak & Foust, 2008; Scott, 1993; Simon & Hanrahan, 2004), and at the *middle* school level including students with autism spectrum disorders and moderate intellectual disabilities (Fletcher et al.). Thus far, *no* research has been conducted on the use of the *TouchMath*© program with money values, including students with mild intellectual disabilities at the high school level.

During the baseline phase, all three of the students demonstrated an inability to solve 3-digit subtraction problems with regrouping. There was an abrupt level change for all three students with no overlapping data points indicating an increase in performance and continued level of competence. An ascending trend was observed for the students during the intervention phase exhibiting marked performance when the intervention was employed. These observations provide evidence that the intervention was effective in teaching the students via the touch-points strategy to subtract 3-digit money values with regrouping. During the intervention probes phase, two of the three students, Trent and Michael, showed dramatic increases in their mathematics performance and reached criterion in the allotted amount of time, five sessions. However, the third student, Alex, required a total of 10 sessions to reach criterion. During the second session, Alex scored well on the second probe but only scored 30% on the following probe. This low score caused Alex not to reach criterion in the allotted amount of time. On subsequent probe scores, Alex averaged 91.4% over the last seven probes. If the one probe were erased then Alex would have reached criterion in five sessions. Finally, during the maintenance phase, all three of the students' mathematics performance showed great variability. For example, Trent sustained an ascending trend throughout the study. After six sessions, Trent retained the necessary target skill set to solve the subtraction problems with regrouping. Michael demonstrated a descending trend across four of the maintenance sessions with a median score of 35%. After the minimum two-day period, Alex completed one maintenance session with a score of 100% before the conclusion of the study. Clearly, further research is needed to determine the ability for students with mild intellectual disabilities to sustain the skills necessary to subtract 3-digit money values with regrouping. To help continue maximum skill proficiency over time, refresher sessions to review the steps and procedures of the touch-points method would be required and additional maintenance probes may need to be conducted.

### *Limitations of the Study*

The following limitations need to be considered to interpret the findings of this study. First, the number of students, only three students, makes it difficult to support arguments for generalization of the touch-points strategy to all students at the high school level. Also, the sample only included students with mild intellectual disabilities and/or autism spectrum disorders and does not represent the characteristics of typical school-age populations. So, the findings cannot be generalized to other disability categories, age, grade, race, and/or other genders. For instance, all three of the students were male in ninth and tenth grade levels. Second, the instructional procedures were conducted on a one-to-one basis and would need to be modified for group instruction. Third, during the intervention and maintenance phases, the students were provided the "dot-notations" on the numbers and a line to write the lowered number for regrouping on the worksheets; however, this limits their ability to fully apply and generalize the strategy to novel situations. Also, the procedures included only one specific target skill set (e.g., 3-digit subtraction problems with regrouping with money values) limiting the ability to generalize these findings to other mathematical skills. Fourth, due to student capability levels, addition and subtraction without regrouping were not considered nor were higher skill level problems. Maintenance data was inconsistent and only one probe was gathered from the last student, Alex, due to a holiday and conclusion of the project, as further investigations are obviously warranted examining maintenance capacities of the touch-points strategy.

### *Implications*

Based on the results of this study and previous findings, there are a number of implications for classroom teachers, both general and special education to consider. The *TouchMath©* program is an easy, simple, and teacher-friendly method to employ as a component of the instructional lesson in a self-contained, remedial and/or inclusive classroom setting. The results support a promising and growing research-base for the use of the *TouchMath©* strategy to help students not only with mild intellectual disabilities and/or autism, but other disability categories, as well as students without disabilities, that exhibit difficulties in basic mathematics instruction. Also, the program allows teachers to adapt their instruction, at a developmentally appropriate level, to meet the student's individual needs and learning styles. More recently, *TouchMath©* has developed a variety of new products to teach such concepts as money applications, coins and counting, mathematics manipulatives (e.g., math fans), and a software program known as *TouchMath Tutor©*, that can easily be modified for students to teach functional skills in a variety of classroom and community-based settings.

### *Future Research*

In the current research literature base, no published, empirical studies have examined the effectiveness of the *TouchMath©* strategy to teach students with mild intellectual disabilities to subtract money values, in fact, even more noteworthy, no studies have explored this technique with high school populations, as much of the limited research-base focuses almost exclusively on elementary-age populations. Future research should address the use of the touch-points method with not only addition and subtraction problems, but with multiplication and division problems, with two and three-digits, with and without regrouping, for students with different types of disabilities in the secondary grade levels. Also, future studies should employ experimental group designs to determine if the strategy can be implemented on a larger scale to reach more than one student at a time. Further consideration towards fading the intervention and providing students additional training time to memorize and independently mark the touch-points properly on the numbers before solving the problem is necessary to determine the efficacy of the strategy. Finally, the probe problems employed in this study presented one instance of regrouping within the problem; therefore, generalization to more difficult skills such as multiple regrouping opportunities or regrouping with zero in the problem should be examined.

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