Not All Created Equally: Exploring Calculator Use by Students with Mild Intellectual Disability

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Abstract: Calculators are widely used in mathematics education, yet limited research examines the effects of calculators for students with mild intellectual disability. An alternating treatments design was used to study the effects of calculator types (i.e., scientific and graphing) on the mathematical performance (i.e., computation and word problems) of five fifth-grade students with mild intellectual disability. Both types of calculators were effective in increasing the accuracy and efficiency of the mathematical performance of all five students. Results support the use of calculators for students with mild intellectual disability when working on computation and word problem-solving questions.

Mathematics education is a critical aspect for successful post-secondary education and employment for students with disabilities (Xin, Jitendra, & Deatline-Buchman, 2005). Yet, students with disabilities often demonstrate lower achievement levels in mathematics than their peers without disabilities and struggle in a variety of aspects, including computational fluency and problem solving (Cawley, Parmar, Fley, Salmon, & Roy 2001; Jitendra, DiPipi, & Perron-Jones, 2002; Parmar, Cawley, & Miller, 1994; Woodward & Montague, 2002). Unfortunately, research on improving mathematical proficiency of students with high incidence disabilities often aggregate students of different disability categories, such as students who have learning disabilities, emotional/behavioral disorders, and mild intellectual disability (Cawley et al., 2001; Luit & Naglieri, 1999). Yet, significant differences exist in the school academic performance of students with mild intellectual disability and other high incidence disability categories, such as student with learning disabilities. Students with mild intellectual disability tend to experience lower academic performance and poorer postschool outcomes (Parmar et al., 1994; Sabornie, Evans, & Cullinan, 2006; Luit & Naglieri, 1999). Specifically in terms of mathematics, students with mild intellectual disability tend to have lower attainment scores and less conceptual understanding (Parmar et al., 1994).

Research on mathematics and students with mild intellectual disability is sparse, particularly at the secondary level (Butler, Miller, Lee, & Pierce, 2001; Hord & Bouck, 2012). In the review of literature published between 1989–1998 only one study focused on students elementary through high school grades and two on middle school grades (Butler et al., 2001). According to the most recent review of literature by Hord and Bouck (2012), only seven articles published between 1999–2010 focused on mathematics instruction for students with mild intellectual disability. Of the seven articles, only four studies focused on middle school students.

Technology, Mathematics, and Students with Disabilities

Within the teaching and learning of mathematics for all students, including students with disabilities, technology has been prioritized (Bender, 2001). In fact, technology is one of the six principles of mathematics education from The National Council of Teachers of Mathematics (NCTM, 2000). Technology—inclusive of such tools as calculators and com-
puters—supports the mathematics development of students. However, little variety exists in terms of the research-base on technology to support students with high incidence disabilities in mathematics (Bouck & Flanagan, 2009); in other words, despite its value for all students, technology for mathematics teaching and learning has received little attention for students with disabilities (Edyburn, 2003).

In a review of the literature on research on technology, mathematics, and students with high incidence disabilities, Bouck and Flanagan (2009) found three main categories of researched technology: calculators, computer-assisted instruction, and anchored instruction. Of the three main categories, calculators received the least attention in research with only five articles published between the years of 1998–2009.

Within the limited research on calculators and students with high incidence disabilities, the majority of studies focused on using calculators as accommodations on assessments (Bouck, 2009; Bouck & Bouck, 2008; Fuchs, Fuchs, Eaton, Hamlett, & Karns, 2000). Fuchs and colleagues (2000) found greater benefits for calculator use by students with learning disabilities on curriculum-based measurement (CBM) assessments focused on “innovative” problem-solving tasks compared to their peers without disabilities. However, students with learning disabilities did not benefit from using calculators on CBM assessments focused on concepts and applications. In a more recent study examining the use of graphing calculators for students with and without disabilities at seventh-grade, Bouck (2009) found greater benefits of calculators for students without disabilities on the post-assessment than for students with high incidence disabilities. When examining four-function calculators as accommodations, Bouck & Bouck (2008) concluded students with high incidence disabilities made significant gains on assessments; however, benefits gained from using calculators for students with high incidence disabilities were not greater than for students without disabilities.

Not surprising given the little research on calculator use for students with high incidence disabilities in general (Bouck & Flanagan, 2009), in conjunction with the little recent research on mathematics and students with mild intellectual disability (Hord & Bouck 2012), limited research exists on calculators and students with mild intellectual disability. In a study comparing the use of calculators and the paper-and-pencil method for solving subtraction problems with junior high school students with mild intellectual disability, students improved performance and accuracy in solving subtraction problems with the use of calculators (Horton, Lovitt, & White, 1992). While not explicitly a calculator, the pentop computer explored by Bouck, Bassette, Taber-Doughty, Flanagan, and Szwed (2009) provided auditory prompts for computing multiplication and division problems. Following use of the pentop computer, middle school students with mild intellectual disability improved their mathematical performance.

Comparison of Calculator Types

Within the research on the impact of calculator types on student performance, mixed results were identified. Although not specific to students with mild intellectual disability, studies on the effects of calculator types on students’ mathematical performance present conflicting results (Hanson, Brown, Levine, & Garcia, 2001; Scheuneman, Camara, Cascallar, Wendler, & Lawrence, 2002). Scheuneman and colleagues (2002) found students who used four-function calculators did not perform as well as those using scientific calculators, and graphing calculators were more effective than four-function or scientific calculators. However, the results of this study are difficult to interpret because students were allowed to use the type of calculator they brought into a testing situation. Hanson and colleagues (2001) found no effects of calculator type on students’ performance of mathematics problems on the National Assessment of Educational Progress (NAEP). More recently, Bouck (2010) found no statistically significant difference between four-function and graphing calculators on the performance of students with and without disabilities (Bouck, 2010).

The purpose of this study was to examine the effects of scientific and graphing calculators on the computation and problem-solving mathematics performance for middle school
students with mild intellectual disability. Two main research questions were addressed:
(a) Do students improve the accuracy and efficiency of solving mathematical problems with the use of scientific or graphing calculator?, and (b) Which type of calculator is more effective in increasing students’ performance in solving mathematical problems: scientific or graphing calculator? Students’ perspectives on using scientific and graphing calculators to assist in solving mathematics problems were also examined.

Method

Participants

Five fifth-grade students attending a suburban middle school in a Midwestern state participated in the study. Students were selected to participate based on the following criteria: (a) level of cognitive functioning (IQ 55–70), (b) no previous experience in using graphing and scientific calculators, (c) similar chronological age, and (d) willingness to participate in the study. Each student received mathematics instruction in a self-contained special education classroom. All students spent 80% of their school day in the same special education classroom and participated in keyboarding, art, music, physical education and health classes in general education settings.

Rick was an 11 year-old Hispanic male student with an IQ of 57 (WISC). Rick’s score based on a statewide assessment (Indiana Statewide Testing for Educational Progress [ISTEP]) was 344/445 and his grade-level equivalency score was 2.1 according to STAR Math assessment. At the time of the study, his instruction focused on one-, two-, and three-digit addition, subtraction and multiplication problems. Rick was an eager student who enjoyed math and other classes.

Amanda was an 11 year-old Caucasian female student with an IQ score of 61 (WISC). Amanda participated in an annual state alternate assessment and her grade-level equivalency score was 1.7 as assessed on STAR Math. Amanda’s assignments were based on one-, two-, three-digit addition and subtraction problems and one- and two-digit multiplication problems. Amanda was sociable and had a good sense of humor, although at times she interrupted her own and peers’ task completion by talking during class.

Kate was an 11 year-old Hispanic female student with an IQ score of 60 (WISC). Kate’s score on a state alternate assessment based on modified achievement standards was 468/474 and her current grade-level equivalency score as assessed on STAR Math was 3.9. Her assignments in mathematics also focused on one-, two-, and three-digit addition, subtraction and multiplication problems. She was a quiet student who enjoyed school and focused on her work. Kate was a hard-working student who completed assignments on time and answered questions during class.

Bob was an 11 year-old African-American male student with an IQ score of 58 (KTEA). Bob scored 459/487 on a state alternate assessment based on modified achievement standards and his grade level equivalency score was 2.2 as assessed on STAR Math. His mathematics assignments focused on one-, two-, three-digit addition, and subtraction problems and one- and two-digit multiplication problems. Bob often became distracted from his work, talked to his peers during class, and interrupted himself and others while working on assignments. He had difficulty with focusing on task at hand, and made excuses to avoid work, such as going out to drink water.

Alex was an 11 year-old Caucasian male student with an IQ score of 68 (WISC). Alex’s score on a statewide assessment was 303/445 and grade equivalency score according to STAR Math assessment was 2.3. Alex’s assignments also focused on addition and subtraction problems based on one-, two-, three-digit number operations and one- and two-digit multiplication problems. Alex was a diligent and energetic student, enjoyed his classes, and completed his work on time.

Setting

Students received mathematics instruction based on the Saxon mathematics curriculum Grade 3 in a self-contained mathematics classroom. The class had two special education teachers and 12 students. All research sessions occurred in a separate classroom with the five students, a special education teacher, and the
first author so as to not distract other students in the class. In a separate classroom, the desks were arranged in rows. Each student sat individually at a separate desk with Rick, Alex and Kate seated in the front row and Amanda and Bob seated in the back row.

Materials

All students used the same materials throughout the study. A graphing calculator (a TI-83 Plus) and scientific calculator (a TI-30Xa), both by Texas Instruments (TI), were used during the intervention and follow-up phases. Prior to beginning the study, an initial evaluation was conducted to assess students’ mathematics skills for two sessions. Evaluation probes included computation and word-problem solving questions based on addition to assess skill levels in solving addition problems; students answered addition questions with greater accuracy. Based on evaluation results and classroom teacher recommendation, subtraction was the focus of the problems. Hence, 10-question probes were developed by the authors to represent three-digit by two-digit subtraction, in alignment with students’ third-grade curriculum. Two-digit numbers used in the problems included a range of numbers from 10 to 99, and three-digit numbers contained numbers ranging from 100–400. The first author created a set of 180 problems to use during the probes: 90 subtraction facts and 90 money-related word problem-solving questions. Money-related word stories were made for problem-solving probes to present the questions in a meaningful manner applicable to everyday life activities. The problems were then randomly selected for placement on the different probes. Each computation probe involved five subtraction questions presented in a vertical position and each word problem-solving probe consisted of five money-related subtraction questions. In both cases, problems involved subtracting two-digit numbers from three-digit numbers, such as 122–38.

Independent and Dependent Variables

The independent variable of the study was the use of scientific and graphing calculators. Students used scientific and graphing calculators to complete subtraction computation and word problem-solving tasks during intervention and follow-up phases.

Dependent variables of the study were the accuracy and efficiency of performing subtraction computation and word problem-solving questions with the use of calculator as a mathematical tool. The accuracy of task performance was defined as the percentage of questions correct out of ten during each session: five computation and five word problems.

The efficiency of task performance was defined as the time duration to perform the set of problems in each session. A digital watch, with minutes and seconds indicated, was used to measure the duration of task performance during each session. Duration was recorded by writing down the start and end time of both subtraction computation and word problem-solving probes during each session for each student; the times were noted separately for each problem type.

Experimental Design

An alternating treatments design (Barlow & Hayes, 1979) was used to identify and compare the effectiveness of graphing and scientific calculators on students’ performance of computation and word problem-solving tasks. This design allowed researchers to examine two types of calculators with the same students in an alternating order between sessions and control for sequence effects (Barlow & Hersen, 1984). The order of calculators was determined by the flip of a coin. No more than two consecutive sessions with the same calculator occurred. If the flip of a coin indicated the same calculator for the third time consecutively, then researchers implemented the other calculator to control for order effects.

Data Collection

Researchers used permanent product recording to measure the percentage of correct performances on subtraction computation and word problem-solving tasks after students completed the task, and duration recording to determine the time each student spent on completing the tasks during each session (Kennedy, 2005). Duration recording started
when students began solving the first problem following the directions given by the researcher and continued until each student raised his/her hand indicating completion of the probe separately for each problem type.

Procedure

Baseline. Baseline consisted of five sessions until a stable state of responding was achieved (Kennedy, 2005). All students received the same instructions at the beginning of each baseline session: “Each of you will receive a paper with five subtraction and five word problem-solving tasks. You need to compute subtraction facts and solve word problem-solving tasks. After you finish the first part, subtraction facts, you need to raise your hands. You can begin working on the second part, word problem-solving questions, when you are told to begin the second part. When you finish word problem-solving questions, please raise your hands.” Students completed one set of computation and word problem-solving tasks during each baseline session without the use of any calculator. Students did not receive any additional assistance or prompting in completing tasks.

Pre-training. Prior to beginning intervention, students learned how to properly use graphing and scientific calculators to input numbers and perform operations. Training instructions focused on teaching students how to turn calculators on and off, explanation of the buttons, and how to input subtraction problems into the calculators. Students received one session of 30-minute training for each calculator type. Any questions on using both scientific and graphing calculators were answered during this phase. Students moved to the intervention phase after successfully completing five computation and five word-problem solving subtraction questions using each type of calculator.

Intervention. Intervention lasted ten sessions and consisted of two conditions: graphing and scientific calculator conditions. Students used graphing and scientific calculators in an alternating order between sessions to perform one set of computation and word-problem solving tasks during each session; the condition during a session was determined by a flip of a coin with no more than two consecutive sessions per condition. All students received the same instruction at the beginning of each intervention session: “Each of you will receive a paper with five subtraction and five word problem-solving tasks. You need to compute and solve word problem-solving tasks using a given calculator. After you finish the first part, subtraction facts, you need to raise your hands. You can begin working on the second part, word problem-solving questions, when you are told to begin the second part. When you finish word problem-solving questions, please raise your hands.”

Follow-up Phase. Follow-up lasted three sessions and students used the more effective type of the calculator from the intervention phase. The more effective calculator type for each student was determined by measuring the combined total percentage of correct answers both for subtraction computation and word problem-solving questions. Students received the same instruction as in the intervention phase. Rick and Kate used a scientific calculator, and Bob and Alex used a graphing calculator. Amanda answered the questions equally correct with both types of calculators during the intervention phase. Therefore, she was asked what type of calculator she preferred to use. Amanda selected a graphing calculator to use during the final phase of the study.

Interrater Agreement

The reliability rater and second author randomly selected 34.4% of all probes and independently checked the number of correct and incorrect performances on subtraction computation and word problem-solving tasks. The reliability rater measured 32% of baseline, 36% of each intervention condition, and 33% of the follow-up condition for all students. Interrater agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and then multiplying the amount by 100%. The interrater agreement was 100% for all students across all phases. Additionally, another trained second observer recorded data on duration of solving subtraction computation and word problem-solving questions for all students across 20% of baseline, 40% of each intervention condition and 33% of the fol-
low-up condition. The interrater agreement for duration was calculated by dividing the smaller amount of duration by the larger amount of duration, and then multiplying the amount by 100%. The interrater agreement for duration during baseline was: 98.5% for Kate on subtraction computation and 100% on word problem-solving, 100% for all other four students across both tasks. The interrater agreement during intervention was: 100% for all students during scientific calculator condition across both subtraction computation and word problem-solving; and 94% for Bob on subtraction computation and 100% on word problem-solving, 98.85% for Alex on word problem-solving and 100% on subtraction computation, and 100% for all other three students across both problem types during the graphing calculator condition. The agreement during follow-up phase was 100% on subtraction computation and 98.7% for Rick on word problem solving and 100% for all other four students across both problem types.

Treatment Fidelity

A second observer collected data independently to ensure the correct implementation of intervention procedures. Prior to the beginning of the intervention phase, the reliability observer became familiar with the intervention procedures and asked any questions she had about intervention steps. All questions asked have been answered prior to beginning treatment reliability data collection. The reliability observer used a checklist of steps to put check marks for each step of the intervention procedure implemented correctly during 40% of each intervention condition. Treatment reliability checklist contained the following steps: (a) students were given a graphing and scientific calculator alternatively during intervention sessions, (b) students were told they needed to perform the given computation and word problem-solving tasks with the use of a graphing/scientific calculator, (c) students used a graphing/scientific calculator in solving computation and word problem-solving tasks, (d) each student independently performed tasks with the use of a scientific/graphing calculator. The number of occurrences was divided by the number of occurrences and nonoccurrences and then multiplied by 100% to calculate treatment reliability. The treatment reliability measure was 100% during intervention sessions.

Social Validity

Following the pre-training and intervention phases, informal interviews were conducted to determine students’ and a teacher’s perspectives on the importance, social acceptability and appropriateness of the calculators used in the study. The questions asked of the students and the teacher are listed in Table 1.

Results

Figures 1, 2, 3, 4 and 5 illustrate the effectiveness of graphing and scientific calculators on students’ performance of computation and word problem-solving tasks. Table 2 presents the mean duration of students’ performance across conditions and tasks.

Rick.

Rick’s baseline mean score of correct answers was 52% for computation and 48% for word problem-solving questions. A visual analysis of data indicated an increase in the percentage of questions answered correctly during both the intervention and follow-up phases over baseline levels. During the intervention phase, his mean percentage of correct performance increased to 92% for computation and 88% for word problems using a scientific calculator and 96% for computation and 68% for word problem-solving using a graphing calculator. Additionally, the percentage of non-overlapping data (PND) between the baseline and intervention phases for subtraction computation was 80% for each calculator type. PND for word problems between the baseline and intervention phases was 80% for scientific and 40% for graphing calculator. During the follow-up phase with a scientific calculator, Rick obtained a mean score of correct performance of 80% for computation problems and 93.3% on word problems.

Rick’s mean duration score gradually decreased from baseline to intervention and follow-up phases across both calculators. When working on computation facts, Rick’s duration mean for baseline was 1:53. During the intervention phase, his mean duration score decreased to 1:02 (a scientific calculator) and
1:09 (a graphing calculator). Use of a scientific calculator during the follow-up phase resulted in a duration mean of 1:30 for computation problems. Similarly, Rick’s mean duration score when working on word problem-solving questions decreased across all phases using both types of calculators (i.e., baseline was 2:54, a scientific calculator was 2:09, and a graphing calculator was 1:52). During word problems during the follow-up phase, Rick’s mean duration score using a scientific calculator was 2:14.

Amanda. During baseline sessions, Amanda correctly answered an average of 8% of computation and 0% of word problem-solving questions. A visual analysis of data indicated an immediate increase in the percentage of correct answers during both the intervention and follow-up phases. She obtained a mean score of 88% correct performance on computation and 92% on word problems using a scientific calculator, and 100% on computation and 80% on word problems using a graphing calculator. PND between the baseline and intervention phases for both subtraction computation and word problems was 100% for each calculator type indicating the effectiveness of the intervention. During the follow-up phase, Amanda’s mean score of correct performance was 93.3% for computation and 80% for word problems using a graphing calculator.
Amanda’s baseline duration measures resulted in a mean score of 3:38 for computation facts. During the intervention phase, her mean duration score decreased from the baseline phase: 2:44 when using a scientific calculator and 2:54 when using a graphing calculator. Her follow-up phase duration score using a graphing calculator was 2:46. The mean duration score during word problem-solving questions resulted in 4:03 during baseline, 4:40 (a scientific calculator) and 3:45 (a graphing calculator) during intervention, and 4:08 during the follow-up phase.

Kate. Baseline mean score of correct answers for Kate was 4% on computation and 0% on word problems. Visual analysis of data demonstrated an increase in the percentage of problems solved correctly from baseline to intervention and follow-up phases. During the intervention phase, Kate’s mean score increased resulting in an average of 88% correct for computation and 96% for word problems when using a scientific calculator, and 96% correct on computation and 72% on word problems when using a graphing calculator. PND between the baseline and intervention
phases for both types of problems was 100% for each calculator type. During the follow-up phase using a scientific calculator, Kate obtained a mean score of 93.3% correct performance across both computation and word problem-solving questions.

Duration measures during baseline resulted in a mean of 3:06 for computation and 3:55 for word problem-solving questions. Kate’s mean duration score of performance decreased across phases for computation and word problem-solving questions. Duration measures during the intervention phase resulted in a mean of 2:16 (a scientific calculator) and 2:08 (a graphing calculator) when answering computation facts. Similarly, duration scores for word problem-solving questions indicated a decrease from baseline sessions: 3:14 (a scientific calculator) and 2:28 (a graphing calculator). During the follow-up phase using a scientific calculator, mean duration score was 1:52 for computation and 2:09 for word problem-solving questions.

Bob. Bob’s mean baseline score for correctly answered questions across computation was 12% and 0% for word problems. During the intervention phase, his mean correct performance increased in both phases: 92% for computation and 76% for word problems when using a scientific calculator and 88% for computation and 96% for word problems when using a graphing calculator. PND between the baseline and intervention phases for both types of problems resulted in 100%
for each calculator type. During the follow-up phase with a graphing calculator, his mean score was 93.3% on computation and 86.7% on word problems.

Bob’s mean duration score in performance indicated a gradual decrease across phases. Baseline mean duration score was 4:37 for computation questions and 6:10 for word problems. While using a scientific calculator during the intervention phase for computation questions, duration scores decreased, resulting in a mean of 4:30 using a scientific calculator and 3:34 using a graphing calculator. When using a graphing calculator during the follow-up phase to answer computation questions, Bob’s mean duration score was 3:21. When working on word problem-solving questions, mean duration scores were: 5:34 (a scientific calculator) and 4:12 (a graphing calculator) during intervention, and 4:15 during the follow-up phase using a graphing calculator.

Alex. During baseline condition, Alex correctly answered an average of 4% on computation and 0% on word problems. Visual analysis of data indicated a considerable increase in performance during both intervention conditions: an average of 88% correct response for computation and 92% for word problems using a scientific calculator and 96% accuracy on computation and 92% on word problems using a graphing calculator. PND for both types of problems resulted in 100% for each calculator type between the baseline and in-

Figure 3. Percentage of problems answered correctly for Kate.
tervention phases. During the follow-up phase using a graphing calculator, Alex’s average score of correct responses was 86.7% for computation and 100% for word problems.

When answering both computation and word problem-solving questions, Alex’s mean duration score decreased across phases. Baseline mean duration score for computation questions was 1:55. Duration measures for answering computation questions during the intervention phase indicated a mean of 1:05 (a scientific calculator) and 1:18 (a graphing calculator). When solving word problem questions, duration mean resulted in the following: baseline—2:31, intervention—2:05 (a scientific calculator) and 1:49 (a graphing calculator). During the follow-up phase using a graphing calculator, Alex’s mean duration performance was 1:38 on computation and 1:31 on word problems.

Social Validity

Following the pre-training phase, Amanda, Rick and Alex expressed their preference for a scientific calculator, indicating such reasons as ease of use, simple layout, and belief they would be able to complete computation and problem-solving tasks with accuracy. When asked about their opinions on using a graphing calculator, they felt the complex layout of a graphing calculator, such as more unfamiliar functions, would confuse them and make it difficult for them to solve problems. Alternatively, Kate and Bob indicated they liked the graphing calculator, and felt the presence of a
lot of functions or buttons might be helpful in solving problems. After using both types of calculators during the intervention phase, Rick and Alex expressed the same reasons for favoring a scientific calculator and Bob for a graphing calculator. Kate indicated her pref-

**TABLE 2**
Mean Duration Scores in Minutes and Seconds for Computation and Word-problem Solving Questions

<table>
<thead>
<tr>
<th>Student</th>
<th>Computation</th>
<th></th>
<th></th>
<th></th>
<th>Problem-solving</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Scientific</td>
<td>Graphing</td>
<td>Follow-up</td>
<td>Baseline</td>
<td>Scientific</td>
<td>Graphing</td>
</tr>
<tr>
<td>Rick</td>
<td>1:53</td>
<td>1:02</td>
<td>1:09</td>
<td>1:30</td>
<td>2:54</td>
<td>2:09</td>
<td>1:52</td>
</tr>
<tr>
<td>Amanda</td>
<td>3:38</td>
<td>2:44</td>
<td>2:54</td>
<td>2:46</td>
<td>4:03</td>
<td>4:40</td>
<td>3:45</td>
</tr>
<tr>
<td>Kate</td>
<td>3:06</td>
<td>2:16</td>
<td>2:08</td>
<td>1:52</td>
<td>3:55</td>
<td>3:14</td>
<td>2:28</td>
</tr>
<tr>
<td>Bob</td>
<td>4:37</td>
<td>4:30</td>
<td>3:34</td>
<td>3:21</td>
<td>6:10</td>
<td>5:34</td>
<td>4:12</td>
</tr>
<tr>
<td>Alex</td>
<td>1:55</td>
<td>1:05</td>
<td>1:18</td>
<td>1:38</td>
<td>2:31</td>
<td>2:05</td>
<td>1:49</td>
</tr>
</tbody>
</table>

Figure 5. Percentage of problems answered correctly for Alex.
ference for a scientific calculator; however, she felt both calculators were useful in calculating and solving problems. Although Amanda liked using both types of calculators, she enjoyed a graphing calculator better than a scientific calculator. All students thought they answered computation and word problem-solving questions with greater accuracy when using a calculator.

During the initial interview process, the classroom teacher felt calculators might be effective in improving students’ performance in solving computation and word problem-solving questions, and help students solve more advanced mathematical calculations. She expressed that calculators may serve as an alternative to what her students currently were doing—using their fingers or number lines to solve computation and problem-solving questions. However, she also worried that her students might rely on using the calculators even with basic problems. Following intervention, the teacher expressed satisfaction with the use of calculators for her students and indicated using the calculators helped her students learn how to solve more advanced problems without having to rely on number lines. When asked if she would use a graphing and/or scientific calculator in her classes, she indicated negatively, citing the presence of advanced functions on these calculators that were above the students’ current level of mathematics. She stated that basic four-function calculators were sufficient to use with her students at their level of mathematics performance.

Discussion

The purpose of this study was to examine the effectiveness of scientific and graphing calculators as instructional tools for solving subtraction computation and word problems for students with mild intellectual disability. Three main results were found: (a) an increase in students’ correct performance of subtraction computation and word problem-solving questions using both types of calculators, suggesting the effectiveness of scientific and graphing calculators, (b) use of calculators resulted in a decrease in the amount of time students spent on answering subtraction computation and word problem-solving questions, and (c) the effectiveness of the actual calculator varied by student, as some students improved in the percentage of correct answers more with the scientific calculator while others with the graphing calculator; students also held different perceptions towards the two calculator types.

The increase in students’ accurate performance with use of a calculator supports previous research on the effectiveness of calculators for students with mild intellectual disability in solving subtraction problems (Horton et al., 1992), as well as general research on the effectiveness of calculators for students without disabilities (Ellington, 2003). All students in the current study improved in the percentage of subtraction computation and word problem-solving questions from baseline (i.e., paper and pencil) to intervention sessions upon introduction of both scientific and graphing calculators. Results suggest that when given a calculator students can solve computation and word problems with greater accuracy. This is supported by low levels of baseline performance in both subtraction computation and word problem-solving questions and a high increase in performance once students had access to calculators.

The positive impact of a calculator was particularly noticeable with regards to students’ responses to word problems. Four students averaged 0% correct during baseline and improved in their performance to 60%–100% success rate using calculators. Student success rate with the calculators on the word problems suggested students possessed a conceptual understanding of how to solve the word problems, but struggled with other facets, such as the computation. Hence, allowing these students access to calculators during instruction can assist them in overcoming challenges and enabling them to work on more advanced problems. In other words, a calculator serves as an effective accommodation (Blackhurst, 2005; Hasselbring & Glaser, 2000).

Calculators as assistive technology support not only students’ correct performance in mathematics, but also efficiency of solving mathematical problems. For four of the five students, calculators resulted in a decreased amount of time spent on answering subtraction computation and word problem-solving
questions. Thus, calculators can serve as a cognitive prosthesis and augment mathematical performance of students with disabilities (Edyburn, 2006). Teachers should allow students to use calculators to perform computation operations and spend more time on teaching conceptual understanding of problems and even progressing to more advanced mathematics. This further helps bridge the achievement gap between students with and without disabilities (Blackhurst, 2005). The efficiency of using calculators in both computation and word problem-solving questions further supports using calculators as assistive technology.

The final main finding suggested differences amongst students regarding the impact of calculator types on students’ performance in terms of accuracy and efficiency of problems solved. Though previous research on the impact of various calculator types for students with mild intellectual disability is lacking, comparison of calculator types on other students’ performance presents conflicting results (Bouck, 2010; Hanson et al., 2001; Scheuneman et al., 2002). While Scheuneman et al. (2002) found differences among calculator types—favoring more sophisticated calculators, Hanson and colleagues (2001) found no impact of calculator type on students’ mathematical performance. In the current study, two students performed better with a scientific calculator, two with a graphing calculator, and one with both types of calculators, suggesting the differential impact of calculators on different students. Thus, students with intellectual disability should not be restricted to using only one type of calculator and should be allowed to use the calculator they prefer or feel comfortable using. Further, students with mild intellectual disability should be actively taught to use a calculator, regardless of the type. Students may have been more successful in this study using the calculators given the instruction on how to use each more advanced tool.

Students in this study who indicated a preference for one type of calculator over the other prior to the intervention phase tended to perform slightly better with the preferred calculator during intervention sessions. This did not hold true for one student, Alex, who performed slightly better with a graphing calculator, despite his preference for a scientific calculator both before and after the intervention phase. Student choice of an instructional tool further questions the possible relationship between student preference and achievement. Students’ preferred instructional method was found to be more effective than a non-preferred method when examining student preference of instructional strategies and its effect on task acquisition for students with a moderate intellectual disability (Taber-Doughty, 2005). Thus, student preference of one calculator type over the other might have impacted accuracy and efficiency of questions answered in this study.

Limitations and Future Directions

One of the limitations of this study is a small number of participants; yet the number is consistent with single subject research. Having a large number of participants may have produced different results in identifying the more effective type of calculator, as two students performed better with the scientific calculator, and the other two students performed better with the graphing calculator, and one student performed equally correct with both types of calculators. Research on calculators and students with disabilities primarily focused on using calculators as assessment accommodations for students with learning disabilities (Bouck, 2009; Bouck & Bouck, 2008; Fuchs et al., 2000). However, students with mild intellectual disability have different academic needs and performance than students with learning disabilities (Bouck, 2007; Polloway, Lubin, Smith, & Patton, 2010). Future research is necessary to determine the degree of the effectiveness of calculators with a larger number of students with mild intellectual disability at the secondary school levels. These types of studies will further provide insights into the types effective instructional practices and tools to successfully prepare students for post-secondary education and employment.

Another limitation was the type of computation and word problem-solving questions. The questions students answered did not specifically require the use of scientific or graphing calculators. Students used only basic operation buttons of both calculators to solve problems that could also be performed with a four-function calculator. Thus, future studies...
may examine the impact of graphing and scientific calculators on students’ performance in solving more advanced problems using specific features of these calculators. In addition, future research should compare the effectiveness of a basic four-function calculator to the more advanced calculators.

References


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