The Effects of One Minute Warm Up Procedures on Addition One Minute Fluency Timings

Susan R. Sweeney, William J. Sweeney, and Paul Malanga

This study examined the use of warm up timings with second and third grade special education students before addition one-minute math probes to improve addition fluency. The target behavior was the number of correct single digit answers on the one-minute probe given directly after a warm up probe of the same math problems. An A-B experimental design (Cooper, Heron, & Heward, 1987; Kazdin, 1982) was used to evaluate the frequency of correct answers written across the timing periods. During baseline, 13 practice sessions were conducted to establish a means of daily performance on the one-minute timing. During intervention, data were collected across 14 sessions. During intervention, students were given the same two single digit addition probes each day. The first probe was used as a warm up procedure, while the second one-minute probe was used as a fluency assessment. During intervention, three of the students' data indicated slight level increases, one student's data accelerated at a x1.75, and two students data appeared to decelerate during intervention. All but one student demonstrated higher frequency of correct answers during intervention indicating important performance changes in their overall single digit addition computation. These data suggests that using a warm up cycle before one-minute addition math probes may improve students' performance with the fluency of math facts.

Regular Education teachers as well as Special Education teachers are faced with the ongoing dilemma of teaching math skills to their students. Not only do they need to teach the skill, but they also need to accurately track the progress of their students. Out of this need to instruct students in basic math skills grows the need for effective instruction (Stein, Silbert, & Carnine, 1997). In order to determine the effective instruction, educators must understand that students learn what they are taught, and that they master what they practice (Binder & Watkins, 1989). Many variables influence student acquisition of mathematics. The following variables are at the center of the acquisition process: (1) instructional design, (2) presentation techniques, and (3) organization of instruction (Stein, Silbert, & Carnine, 1997).

In math, curriculum-based research appears to be focused on acquisition of accuracy and fluency with computational facts (Fuchs & Deno, 1992; Fuchs & Deno, 1991; King-Sears, Cummings, & Hullihen, 1994). Student are not only required to add, subtract, multiply, and divide, they are also expected to perform the task with accuracy and speed (King-Sears et al., 1994). Precision Teaching uses the term "fluency" to refer to accuracy plus speed of performance (Binder & Watkins, 1990). Teachers should be interested in the fluency of their students' responses for several reasons. First, rate, like accuracy, indicates how well a student knows his/her facts (Howell & Lorson-Howell, 1990). Second, fluency has functional implications. Some things must be completed quickly (Howell & Lorson-Howell, 1990). Third, fluency is thought
to be related to future generalization and maintenance of a skill (Howell & Lorson-Howell, 1990; Ivarie, 1986; Liberty, Haring, White, & Billingsley, 1988). The combination of the two dimensions of responding--accuracy and frequency of responses over time--gives an incomplete picture of the student's learning (West, Young, & Spooner, 1990; Whalen, Willis, & Sweeney, 1993).

Since fluency is deemed to be one of the primary tasks that teachers must devote instructional time to, Binder and Watkins (1990) advocate the adoption and implementation of data based instructional strategies (Whalen et al., 1993). Examples of data based procedures include Direct Instruction (Stein et al., 1997), Precision Teaching (Sweeney et al., 1992), and time trials (Miller & Heward, 1992). Precision Teaching offers superior tools for practice to the point of fluency, criterion-referenced assessment, and decision-making (Binder & Watkins, 1990). By using daily Charts, teachers and students using Precision Teaching can make timely decisions about teaching methods and teaching materials. Direct Instruction strategies and Precision Teaching evaluation approaches use teaching procedures that enable teachers to maximize the time students spend on instruction (Binder & Watkins, 1989).

Rate per minute is a more sensitive measure of changes in performance than accuracy alone (Howell et al., 1990; Whalen, et al., 1993). Daily time trials enable students to improve their fluency while providing teachers with direct, frequent measures of the students' progress through the use of Standard Celeration Charts (Lindsley, 1990; Miller & Heward, 1992; West et al., 1990; Whalen et al., 1993). Therefore, the use of time trial in the acquisition of math skills is an excellent way to increase fluency (Miller & Heward, 1992; Whalen et al., 1993). Through the use of Direct Instruction and Precision Teaching, the teacher can empower the student to become the leading force in their acquisition of knowledge. Through the use of Direct Instruction and Precision Teaching measurements, the teacher facilitates the learning, becoming the engineer and contingency manager, with responsibilities to the majority, rather than a small minority (Keller, 1968).

By the use of Precision Teaching and the Standard Celeration Chart, students can chart and record their daily performance in a given subject area. The student and teacher can visually see if progress is being made in the instructional material, presentation, or settings (Lindsley, 1992; West, et al., 1990). Students can also compare their present performance to their past performance (Lindsley, 1990), thus showing the students how to become actively engaged in their learning experiences. This process of frequent data collection and decision-making has been shown to increase students' achievement (Fuchs & Fuchs 1986; Howell & Lorson-Howell, 1990).

Through the use of time trials, students can improve fluency by having many opportunities to respond (Whalen et al., 1993). When teaching for fluency, some general considerations should be used:

(a) ensure that all blocks to fluency, such as awkward materials, are removed; (b) model, prompt, and praise frequently; (c) avoid competition between students; (d)
remember that fluency is built primarily through repetition and can be boring; (e) use peers and para-professionals to make instruction efficient; and (f) make sure the rate criteria are appropriate for the individual students (Howell & Lorson-Howell, 1990).

According to West et al. (1990), an effective strategy should remain in effect as long as the student progresses towards the aim of instruction. The instructional aim represents the student’s fluency in a particular skill (Lindsley, 1990; King-Sears et al., 1994; West et al., 1990). Decisions for each student's academic achievement are based upon individual progress toward an instructional aim. Rates of student responses are very sensitive to changes in instruction; therefore, effects of new teaching strategies are seen immediately, and changes in instruction can be made when necessary.

The purpose of this study was to evaluate the use of one minute warm up time trials that preceded the daily one minute addition probes as compared to students' performance on the daily one minute addition probes without a warm up session. These warm up sessions were employed to see if they would improve the students' fluency and celerations of single digit addition calculation.

**METHOD**

*Participants and Setting*

The participants in this study were 6 second graders and 1 third grader in a Mental Disabilities Self-Contained classroom. The second graders consisted of 4 girls who were 8 years of age and one boy who was also 8 years of age. The third grader was a girl 9 years of age. One of the second-grade girls and one of the third-grade girls were English Second Language students. These girls were sisters and their primary language was Spanish. The remaining four students' primary language was English. These students were instructed in mathematics by using the "Touchpoint System".

The participants attend school in a lower socio-economic neighborhood in a moderately sized Mid-Western inner-city school district. The study took place in their primary classroom between 9:00 am and 9:30 am, Monday through Friday, when the students were present at school. Within the classroom, there were 4 other students and two adults (i.e., 2 first-grade students, 2 kindergarten students, a paraprofessional, and one special education teacher). The students sat at the same large table during time trials. Additionally, the room had two computers, several tables and chairs, a filing cabinet, tape player and reading table. During math trials, the first graders and kindergarten children were doing math activities with the paraprofessional.

*Movement Cycle and Materials*

The movement cycle was defined as the number of correctly written single digit addition answers during the one-minute time trial. The one-minute time trial consisted of addition problems that had a sum of 9 or less. The students worked on a 60 problem probe sheet, thus allowing the students to set an instructional aim of 60 correct problems per minute. The
learning channel used for this probe was see-write. At the end of the one-minute time trial, the students and the teacher counted, recorded, and charted the number of correct and incorrect responses made during the time trial.

**Experimental Design**

An A-B experimental design (Cooper, et al., 1987; Kazdin, 1982) was used to evaluate the frequency of correct answers written across the timing periods. The independent variable was the warm up procedure prior to the time trials; the dependent variable was number of correct single digit addition answers written during the one-minute timings. This allowed for comparison of fluency across repeated time trials.

**PROCEDURE**

**Baseline**

The baseline-assessed fluency rates over one minute time trials. During baseline, students were given a minute math trial sheet. The students were instructed in a "see-write" learning channel. The student saw the problem, and then wrote the answer on the 60 problem addition probe sheet. The students were asked to correctly complete as many problems as they could in one minute. Prior to implementing the one-minute timings, the teacher demonstrated and explained the procedures and the one-minute timings to the students. The teacher's instructions were as follows: "I will set a timer for one minute; after the timer is set, I will say 'ready, begin'. At this point you start answering as many problems as you can. When the timer rings, I will say 'stop', You all stop and put pencils down. At this point, I will come to each of you, and we will count the number of correct answers you have written, and then we will chart the answers on the Standard Celeration Charts." The students were asked to repeat the teacher's instructions to ensure that the students understood the directions. After the initial instructions and directions, students completed one addition probe every morning when coming to class during the baseline phase of the study.

**Intervention**

The intervention consisted of one phase where the students were given a one-minute warm up session using the same 60 problem probe sheet as they used during their one minute time trial. Daily, the students performed the warm up one minute timing as previously demonstrated in the baseline phase. The students counted and charted their answers after the warm up timing. Immediately following the warm up timing, the students did another one-minute time trial using the same minute probe. The students also counted and charted their progress after the second one minute timed trial.

**RESULTS**

The data in Table 1 indicate improvement in 5 out of the 6 students in single digit addition calculations with the use of one minute warm up timings prior to their daily one-minute addition fluency timing. During the 13 baseline sessions, the mean performance of the 6 students was 24.13 with a range of means from 18.50 to 36.80.
Means and Ranges for Baseline and Intervention Conditions

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline Mean</th>
<th>Baseline Range</th>
<th>Intervention Mean</th>
<th>Intervention Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elizabeth</td>
<td>20.20</td>
<td>17—28</td>
<td>25.80</td>
<td>15—38</td>
</tr>
<tr>
<td>Jessenia</td>
<td>25.15</td>
<td>25—33</td>
<td>29.71</td>
<td>28—46</td>
</tr>
<tr>
<td>Jessica</td>
<td>36.80</td>
<td>32—50</td>
<td>39.78</td>
<td>29—48</td>
</tr>
<tr>
<td>Samantha</td>
<td>23.46</td>
<td>16—28</td>
<td>18.92</td>
<td>20—36</td>
</tr>
<tr>
<td>Kim</td>
<td>20.69</td>
<td>16—30</td>
<td>27.28</td>
<td>25—35</td>
</tr>
<tr>
<td>Aaron</td>
<td>18.50</td>
<td>18—28</td>
<td>22.92</td>
<td>23—30</td>
</tr>
</tbody>
</table>

Table 2
Celerations and Performance Changes for Baselines and Intervention Conditions

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline Celeration</th>
<th>Baseline Performance Change</th>
<th>Intervention Celeration</th>
<th>Intervention Performance Change*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elizabeth</td>
<td>x1.01</td>
<td>x1.9</td>
<td>x1.80</td>
<td>x2.4</td>
</tr>
<tr>
<td>Jessenia</td>
<td>+1.01</td>
<td>x1.3</td>
<td>x1.01</td>
<td>x1.6</td>
</tr>
<tr>
<td>Jessica</td>
<td>x1.01</td>
<td>x1.6</td>
<td>x1.25</td>
<td>x1.4</td>
</tr>
<tr>
<td>Samantha</td>
<td>x1.01</td>
<td>x2.0</td>
<td>+x1.01</td>
<td>x1.7</td>
</tr>
<tr>
<td>Kim</td>
<td>x1.01</td>
<td>x2.0</td>
<td>x1.25</td>
<td>x1.5</td>
</tr>
<tr>
<td>Aaron</td>
<td>x1.01</td>
<td>x1.5</td>
<td>-x1.25</td>
<td>+1.8</td>
</tr>
</tbody>
</table>

* Lowest to highest performance

This is compared with the 14 sessions conducted during the warm up intervention procedure resulting in the average mean performance of the 6 students of 27.40 with a range of 18.92 to 39.78. During both baseline and intervention, the learning opportunities remained below the record floor (i.e., no errors). Charts 2, 3, and 5 show an improvement during intervention in terms of a slight level changes (i.e., higher overall trends in the data during intervention when compared to baseline) and less apparent overall bounce (i.e., less overall variability in the scores during the intervention when compared to baseline).

Chart 1 shows important improvement as indicated by the steeper slope of the trend during the intervention when compared to the baseline measures. Chart 1 reveals an accelerating data path multiplying at x1.80 during the intervention as compared to a flat trend during baseline that multiplied at x1.01.

Data from Charts 4 and 6, respectively, appear flat or slightly decelerating during intervention when compared to baseline data. Although the student in Chart 6 appears to show a slight improvement in his overall mean during intervention, the trend did not appear to indicate an appreciable improvement with the introduction of the warm up procedure. Table 2 shows the celerations of the learning pictures and the overall performance changes during baseline and intervention.

**DISCUSSION**

Although the results are not as dramatic as the first author had originally
SUCCESSIVE CALENDAR DAYS

COUNT PER MINUTE

SUCCESSIVE CALENDAR DAYS

COUNTING PERIOD FLOORS

MIN  HRS

SUPERVISOR  ADVISER  MANAGER

行为

年龄

标签

计数
SUCCESSIVE CALENDAR DAYS

COUNT PER MINUTE

SUPERVISOR
ADVISER
MANAGER
DEPOSITOR
AGENCY
TIMER
COUNTER
BEHAVIOR
AGE
LABEL
COUNTED

CHART 3
anticipated, the data indicate improvement in 5 of the 6 students when a warm up procedure is used prior to a one-minute time trial for addition math facts fluency. Three of the 6 students showed increases in overall level during the intervention condition when compared to the original baseline. It appears that the warm up procedure may increase overall addition fact fluency as well as reducing the overall variability (i.e., bounce) in the data in a given learning picture. Further improvements are shown by the steeper slope of the trends among several students during the intervention condition.

This research builds upon previous research on the use of time trials to enhance fluency in math facts (Whalen et al., 1993). Similar to the Whalen et al. (1993) study, the current study shows the potential use of one-minute timings combined with math probes to evaluate the fluency of basic computational skills with students in the classroom. The authors also firmly believe and agree with the assumptions made by Miller and Heward (1992) regarding the importance of using one-minute timings to evaluate the fluency levels of students' math performance.

There are two potential reasons for some of the results in this study not being as dramatic as initially hoped. First, all of the students in this study had initially been taught math calculations by using a touch point system. Students were dependent upon using touch points in counting to calculate their math answers. The touching of number points may have acted as a fluency blocker. The first author observed that all of the students continued to use the imaginary touch points on numbers to count up the second number in all of the math problems, even though the touch points no longer existed on their worksheets. This continued use of the touch points limited their ability to respond to addition facts correctly and without hesitation. Secondly, Samantha and Aaron experienced repeated health problems, attendance difficulties, the loss of one's glasses for several days, and unstable and volatile conditions at home. These variables may have interfered with Samantha and Aaron's progress and success at building fluency with addition facts.

Several implications of this research are indicated. Warm up procedures may improve students' performance in developing fluency with math facts. Warm up procedures may be an essential component to effective curricular programming; however, more research needs to be conducted in this area to validate this assumption. Finally, future research in the area of utilizing warm up procedures should also evaluate other curricular areas, such as spelling, oral reading, writing composition, and content in specific areas.

The authors hope that this study encourages other researchers to evaluate the effectiveness of using warm up procedures to help increase students' fluency in content area studies. These procedures will hopefully be used by other educators as a means of improving the academic fluency levels of a wide variety of students, while maximizing the learning potential for all students.
REFERENCES


Keller, F. (1968) "Good-bye, teacher ... Journal of Applied Behavior Analysis, 1, 79-89.


Susan R. Sweeney is affiliated with Sioux City Community Schools; William J. Sweeney and Paul R. Malanga are affiliated with the University of South Dakota.