DIFFERENTIAL EFFECTS OF SELF-MONITORING ATTENTION, ACCURACY, AND PRODUCTIVITY

JOHN W. MAAG AND ROBERT REID

UNIVERSITY OF NEBRASKA-LINCOLN

AND

SAMUEL A. DiGANGI

ARIZONA STATE UNIVERSITY

Effects of self-monitoring on-task behavior, academic productivity, and academic accuracy were assessed with 6 elementary-school students with learning disabilities in their general education classroom using a mathematics task. Following baseline, the three self-monitoring conditions were introduced using a multiple schedule design during independent practice sessions. Although all three interventions yielded improvements in either arithmetic productivity, accuracy, or on-task behavior, self-monitoring academic productivity or accuracy was generally superior. Differential results were obtained across age groups: fourth graders' mathematics performance improved most when self-monitoring productivity, whereas sixth graders' performance improved most when self-monitoring accuracy.

DESCRIPTORS: learning disabled, self-monitoring

Self-monitoring procedures have been applied to diverse populations and behaviors (Mace & Kra-tochwill, 1988). These interventions offer an acceptable alternative to more intrusive procedures (Lloyd & Landrum, 1990; Roberts & Nelson, 1981) and are useful with atypical learners to decrease direct teacher intervention and to improve academic performance. Numerous studies have shown that self-monitoring either attention or academic responding increases on-task behavior (e.g., Blick & Test, 1987; DiGangi, Maag, & Rutherford, 1991; Hallahan, Lloyd, Kosiewicz, Kauffman, & Graves, 1979; Harris, 1986). However, it remains unclear which of the variables in self-monitoring best promotes academic gains (Hallahan & Sapon, 1983; Harris, 1986; Lloyd & Landrum, 1990; Snider, 1987).

Advocates of self-monitoring attention stress its simple and practical nature (Lentz, 1988). This approach presumes that self-monitoring attention has collateral effects on academic responding, and

that any differential effects between the two variables are too small to influence academic achievement (Hallahan & Sapon, 1983; Lloyd, Bateman, Landrum, & Hallahan, 1989; Lloyd & Landrum, 1990). Proponents of self-monitoring academic outcome, on the other hand, question the link between on-task behavior and achievement and cite research indicating that targeting productivity or accuracy is more likely to affect academic responding (e.g., Hoge & Andrews, 1987; Klein, 1979; Petersen & Swing, 1982; Ruggles & LeBlanc, 1985; Treiber & Lahey, 1983). They reason that if increases in on-task behavior are independent of achievement, self-monitoring interventions should focus on active academic responding (Graden, Thurlow, & Ysseldyke, 1983).

Only five studies have examined the differential efficacy of self-monitoring attention versus academic outcome (Harris, 1986; Lloyd et al., 1989; Reid & Harris, in press; Roberts & Nelson, 1981; Rooney, Polloway, & Hallahan, 1985). All studies reported increased on-task behavior for both self-monitoring approaches; neither form of self-monitoring emerged as clearly superior. Lloyd et al. (1989), Rooney et al. (1985), and Roberts and Nelson (1981) found no differences in rate of as-

Requests for reprints may be sent to John W. Maag, Department of Special Education and Communication Disorders, 202 Barkley Memorial Center, University of Nebraska-Lincoln, Nebraska 68583-0732.

signment completion for either self-monitoring approach. Harris (1986) noted that mean levels of the number of correct practices were higher for 3 of 4 students who self-monitored performance; however, decreasing trends in the data rendered this finding inconclusive. Finally, Reid and Harris (in press) found that self-monitoring attention significantly decreased accuracy, whereas self-monitoring performance was more effective for maintaining treatment gains.

Interpretation of these results is hampered by differences in the experimental procedures used for self-monitoring performance as well as the difficulty of the academic tasks. With respect to specific procedures, Lloyd *et al.* (1989) focused on self-monitoring productivity (i.e., the number of math problems completed regardless of accuracy), and Rooney *et al.* (1985) had students self-monitor incorrect responses to problems appearing on arithmetic worksheets. In contrast, Roberts and Nelson (1981) asked students to self-record the number of correct arithmetic problems, and Harris (1986) and Reid and Harris (in press) had students self-record and graph the total number of words spelled correctly after finishing practice sessions.

Differences in task demands were also evident across studies. For example, Roberts and Nelson (1981) and Rooney *et al.* (1985) held academic difficulty constant. Lloyd *et al.* (1989) increased difficulty periodically by presenting new content, whereas Harris (1986) and Reid and Harris (in press) kept the task constant but introduced new material throughout their study. These task-demand differences suggest a need to evaluate the effects of self-monitoring for new learning (Snider, 1987). Although most studies have examined only the effects of self-monitoring on skills for which individuals are already proficient, some evidence suggests that task difficulty may differentially affect performance (Friedling & O'Leary, 1979).

The present study compared the effects of self-monitoring attention, academic productivity, and academic accuracy on mathematics performance. Content difficulty was controlled by having students self-monitor problems they performed accurately but for which they required practice to become

fluent (responding correctly and quickly). New skills were introduced systematically throughout the study. Curriculum-based assessment procedures (Howell & Morehead, 1987; Salvia & Hughes, 1990) were used to determine appropriate skills for instruction and independent practice. We hypothesized that self-monitoring different target variables would not differentially affect on-task behavior, but that self-monitoring academic responding would result in greater reactivity for academic productivity and accuracy because of the direct relationship between the self-monitoring targets and the outcome variables.

METHOD

Subjects

One female and 3 male fourth graders (mean age = 9 years 3 months) and 2 male sixth graders (mean age = 11 years 5 months) participated in the study. All subjects were classified as learning disabled according to their school district's criteria, which were similar to those of the federal government (*Federal Register*, 1977). Full-scale scores on the Wechsler Intelligence Scale for Children-Revised (WISC-R) for 5 of the 6 students met these criteria: Mark, 100 (verbal = 105, performance = 93); Tina, 89 (verbal = 97, performance = 82); Jose, 81 (verbal = 70, performance = 96); Shawn, 87 (verbal = 94, performance = 88); J. T., 85 (verbal = 94, performance = 80); and Keith, 99 (verbal = 102, performance = 95). Because English was not Jose's primary language, his full-scale IQ score of 81 was not considered in the placement decision. Instead, he was identified as learning disabled based solely on his low achievement scores. Wide Range Achievement Test-Revised (WRAT-R) mathematics scores for Mark, Tina, Jose, Shawn, J.T., and Keith were 80, 70, 66, 65, 60, and 78, respectively.

The students received resource-room special education services 1 to 3 hr daily. Their general education teachers described the students as demonstrating high levels of off-task behavior and low levels of task completion on mathematics assignments during independent practice activities in the

mainstream setting. When the study was initiated, students were working on the following mathematics objectives: Mark and Jose, addition and subtraction facts (0–20); Tina and Shawn, add one-digit and two-digit numbers without regrouping; J.T., multiplication facts (0–10); and Keith, multiplication facts (0–20).

Setting

General education. Data were collected during 30-min independent mathematics practice sessions in one sixth-grade and two fourth-grade general education classrooms. Each practice session was preceded by a 40-min period of mathematics instruction that consisted of the teacher lecturing and students computing the answers to problems at the blackboard. The classrooms were approximately 6 m by 6 m with five rows of six desks each, where all students independently worked on mathematics assignments. There were 28 students in the sixth-grade classroom of which J.T. and Keith were members, and 29 students in the two fourth-grade classrooms. Jose and Shawn attended one fourth-grade classroom, and Mark and Tina attended the other. The three general education teachers were unaware of the purpose of the study. They were told that any alterations in the participating students' routine were part of their individualized special education program.

Resource room. Students received approximately 30 min of teacher-led remedial mathematics instruction in the special education resource room prior to returning to the general education classroom for independent practice with self-monitoring. The 4 fourth-grade participants received math instruction at 10:00 a.m. along with 4 other students. The 2 sixth-grade participants received mathematics instruction in the resource room from the same teacher at 1:00 p.m. along with 3 other students.

The self-monitoring procedures were taught in the resource room before the self-monitoring conditions were implemented. The size of the classroom was approximately 5 m by 9 m. Participating pupils sat at two U-shaped tables with the special education teacher in the middle. A blackboard was

directly behind the teacher. Mathematics instruction was administered to the entire group using direct instruction. Specifically, the teacher began the lesson with a review before introducing the current topic. She then wrote problems on the blackboard and modeled the problem-solving strategy. Students paraphrased the strategy and chorally responded to questions about strategy use.

The resource-room teacher used curriculum-based assessment regularly to determine appropriate mathematics objectives for all students (Howell & Morehead, 1987). First, survey tests were administered to identify general areas of student performance in mathematics. Next, specific probes or criterion-referenced tests were administered to identify specific instructional objectives. Performance on the instructional objectives was continuously monitored. Instructional decisions about specific objectives were based on results from the criterion-referenced tests.

Target Variables

Three target variables were measured: (a) percentage of on-task behavior, (b) academic productivity (number of problems completed), and (c) academic accuracy (percentage of problems completed correctly). Based on the criteria developed by Lloyd et al. (1989), on-task behavior was defined along two dimensions: (a) pupils' use of their hands (e.g., manipulating a pen or pencil, raising their hands, counting on their fingers) and (b) where the students' eyes were directed (e.g., looking at assigned work, the teacher, or peers). Thus, occurrence of on-task behavior was noted when students were looking at the independent practice mathematics sheets, holding or writing with a pencil, or making erasures.

To determine appropriate instructional objectives and criteria for acceptable performance (CAP) in mathematics, and to develop practice sheets for assessing academic productivity and accuracy, the mathematics section of the Multilevel Academic Survey Test (MAST) (Howell, Zucker, & Morehead, 1985) was administered to each student. The MAST is a criterion-referenced test designed to identify areas of instructional focus. Based on each

student's error pattern on the MAST, specific probes were subsequently selected from the Multilevel Academic Skills Inventory (MASI): Math (Howell, Zucker, & Morehead, 1982) to identify the correct skill (objective) at which to begin instruction. The specific battery of the MASI is comprised of 122 sequenced and cross-referenced criterion-referenced tests that assess 88 specific areas of computational content.

Independent practice levels were identified from the MASI as those objectives on which the student had demonstrated 80% accuracy during direct instruction in their resource room but on which they were not yet fluent. After achieving 80% accuracy during independent practice in the mainstream setting, students began practicing the next objective being taught by their special education teacher in the resource room.

To examine effects of self-monitoring on academic variables, data on both productivity and accuracy were collected. Academic productivity was determined by tallying the number of mathematics problems completed (regardless of accuracy) during 15-min recording sessions. To avoid a ceiling effect, each practice sheet contained 40% more problems than the CAP specified by the MASI. Academic accuracy was determined by dividing the number of problems correctly completed by the total number of problems completed and multiplying by 100%.

Data Collection and Reliability

Data were collected in the general education classrooms during independent practice sessions. Three graduate students collected direct observation data; two additional graduate students recorded interobserver reliability data. Neither observers nor teachers were aware of the purpose of the study. Observers were provided with descriptions of target behaviors and received feedback during practice sessions. All five observers reached 80% agreement before the study began. Observers used a 3-s momentary time sampling procedure that rotated across subjects sequentially (Lloyd *et al.*, 1989; Thomson, Holmberg, & Baer, 1974). Thus, the behavior of

each pair of students in the three classrooms was successively sampled at 3-s intervals for the duration of 15-min recording sessions, yielding a total of 100 observations per session for each student. Interobserver agreement was assessed during 26 (39%) of the sessions. Total agreement, occurrence agreement, and nonoccurrence agreement were calculated on an interval-by-interval basis by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Mean total agreement during experimental phases for on-task behavior was as follows: baseline 93.9% (range, 81% to 100%), self-monitoring 95.3% (range, 75% to 100%), and follow-up 97.2% (range, 95% to 100%). Occurrence agreement for on-task behavior averaged 93.8% in baseline (range, 83% to 100%), 96.2% in self-monitoring (range, 78% to 100%), and 99.2% during follow-up (range, 97% to 100%). Mean nonoccurrence agreement for on-task behavior was as follows: baseline 94% (range, 52% to 100%), self-monitoring 92.5% (range, 50% to 100%), and follow-up 92% (range, 71% to 100%). Mean agreement for number of mathematics problems completed and problems correct was 100%.

Experimental Design

A combined multiple schedule design and multiple baseline across subjects was used to assess the effects of self-monitoring. Introduction of independent variables was staggered for three sets of dyads: Mark and Tina, Jose and Shawn, and J.T. and Keith. Hence, three multiple baseline designs were implemented concurrently across 2 subjects each. To minimize carryover effects inherent in designs with fast-paced alternations of components (Hains & Baer, 1989), only one self-monitoring procedure was presented per day, resulting in a 24-hr lapse between conditions.

In addition, two other precautions used by Lloyd *et al.* (1989) were taken: (a) All practice sheets and self-monitoring cards were color coded to help students discriminate among self-monitoring conditions, and (b) the signal tones used to prompt students to self-monitor differed in pitch for each condition. Tones used to cue self-monitoring oc-

curred at random intervals ranging from 10 s to 90 s (average 45 s).

Self-Monitoring Procedures

Each student received training in three types of self-monitoring: self-monitoring attention, self-monitoring productivity, and self-monitoring accuracy. The procedures for self-monitoring attention and productivity closely followed those of Hallahan et al. (1979) and Lloyd et al. (1989), respectively. However, the procedure for self-monitoring accuracy differed substantially from that used by Rooney et al. (1985). For all three conditions, the experimenter first modeled and verbalized the self-monitoring steps. Next, the experimenter modeled performance while the student verbalized the steps. Finally, the student verbalized and performed the self-monitoring procedure. Students were required to demonstrate proficiency by correctly and independently performing and verbalizing all steps prior to use in the general education classroom. Students were then allowed to practice each procedure for 10 min.

Self-monitoring attention. The teacher began training by briefly discussing the importance of paying attention in general and in particular to working on mathematics practice sheets. Students were instructed to self-record on their recording sheets whether or not they were on-task when cued by a taped tone. As an additional cue, on-task behaviors were listed on the recording sheet. These cues were provided only in this condition. Productivity and accuracy of academic performance were not mentioned during training.

Self-monitoring productivity. When cued by the taped tone, students were taught to mark the problem on which they were working, count the number of problems completed since the previous tone, and record the number on a recording sheet. No emphasis was placed on demonstrating the on-task behavior or on the accuracy of answers. During data collection, compliance with this procedure was monitored by comparing the number of students' tallies with the number of problems completed on the practice sheets. Students' self-recording accuracy was 98%.

Self-monitoring accuracy. In this condition, students counted how many problems they had completed correctly since the previous tone and recorded the number on a tally card. In addition to the practice sheets, students were provided with a correction sheet on which Post-it® notes covered the correct answer to each problem. When the tone sounded, students were to remove the tag only from those problems that they had completed. If the answer was correct, students placed a star next to the problem and recorded it on the tally card. If the answer was incorrect, they circled the problem as a reminder to correct it during the last 10 min of the independent practice session. As in the previous condition, no emphasis was placed on demonstrating on-task behavior or on the number of problems completed. In order to determine that students used the correction procedures properly, we compared their self-recording sheets to their practice sheets after each session.

Experimental Phases

Baseline. Tape-recorded tones were introduced to account for possible effects of the signaling device on student performance (Lloyd et al., 1989). In addition, the tape was started at different places on the recording to reduce the likelihood of students learning the sequence of intertone intervals. Students worked on their mathematics practice sheets during the independent practice session in the general education classroom. No specific instructions were provided; although students were required to verbalize the classroom rules that applied to all students.

Self-monitoring. Self-monitoring took place only in the general education classrooms. Training for each self-monitoring procedure occurred in the special education resource room before the independent practice session. One 20-min session was presented for each self-monitoring procedure immediately before the first session of the alternating-treatments phase for that procedure. After weekends and absences, a 5-min review session was conducted. At the beginning of each independent practice session, students were reminded of the type of self-monitoring procedure they would be using. No feedback

Figure 1. Percentage of intervals on-task for Mark and Tina across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

on their self-recording accuracy was provided. The treatment order each day was randomly determined; however, no condition occurred more than three times per student within a calendar week.

Choice. Concern for the social validity of the behavioral interventions (e.g., Mace, Brown, & West, 1987) led us to examine the acceptability of the self-monitoring procedures. At the conclusion of the self-monitoring phase, students were interviewed by an experimenter to determine which self-monitoring procedure they preferred. Each student was asked, "If you had to choose whether you wanted to use self-monitoring attention, self-monitoring productivity, or self-monitoring accuracy, which would you pick?"

Fade. Self-monitoring was faded using a sequential withdrawal design (Lloyd *et al.*, 1989). Fading occurred the first school day after the choice phase. An experimenter informed students that the

tones would no longer be signaled, but that they were to continue self-monitoring whenever they thought about it. Two days later, the students were instructed to stop self-recording their performance.

Follow-up. After discontinuing self-monitoring, data on students' on-task behavior and academic productivity and accuracy were collected for two additional sessions to assess maintenance of treatment effects. The first follow-up session occurred immediately after the fade phase; the second took place 10 days after Session 1.

RESULTS

Means, medians, standard deviations, and ranges for each dependent variable appear in Appendices A through C. Results for on-task, productivity, and accuracy for each dyad are presented in Figures 1 through 9. No apparent relationships emerged between changes in the dependent variables and introduction of new instructional objectives. During the choice, fade, and follow-up phases, the fourth graders (Mark, Tina, Jose, and Shawn) elected to self-monitor productivity, whereas the sixth graders (J.T. and Keith) self-monitored accuracy. Each student's choice of self-monitoring procedure corresponded to the procedure resulting in optimal academic performance.

On-Task Behavior

Results were consistent with previous research reporting increases in on-task behavior regardless of the type of self-monitoring procedure employed. That is, the mean percentage of intervals on-task increased noticeably for all but 2 students (J.T. and Keith) in all treatment conditions.

Mark and Tina. All three treatments produced improvements in Mark's level of on-task behavior (Figure 1). Self-monitoring productivity was superior to self-monitoring both attention and accuracy. Mark's levels of on-task behavior were maintained during the choice condition; however, decreased levels and a slightly descending trend were noted during fade and follow-up. Although on-task behavior decreased, it remained at levels 200% above baseline. Tina's performance did not

Figure 2. Percentage of intervals on-task for Jose and Tina across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

Figure 3. Percentage of intervals on-task for J.T. and Keith across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

display the same pronounced effects as Mark's. Although mean levels increased for accuracy and attention self-monitoring, only productivity self-monitoring raised her on-task behavior consistently above baseline levels. During the choice phase, Tina's percentage of on-task behavior remained constant. However, during fading, on-task behavior began descending and by follow-up had reached baseline levels.

Jose and Shawn. Improvement in on-task behavior occurred for Jose in all three self-monitoring conditions (Figure 2). Productivity and attention self-monitoring produced the highest levels, with little difference between the two conditions. Mean percentage of on-task behavior remained stable and was well above baseline levels during the choice, fade, and follow-up conditions. All three self-monitoring conditions yielded increases in Shawn's on-task behavior, and no intervention showed clear

superiority. The percentage of on-task behavior dropped slightly but remained stable and was above baseline levels during the choice, fade, and follow-up phases.

J.T. and Keith. Self-monitoring accuracy immediately increased the percentage of J.T.'s on-task behavior compared to productivity and attention self-monitoring (Figure 3). Self-monitoring of productivity produced slight increases in on-task behavior, and self-monitoring attention produced negligible improvement. On-task behavior remained stable during the choice phase, but a decreasing trend became evident during fading. At follow-up, the percentage of on-task behavior remained above baseline levels. Keith's pattern for on-task behavior was similar to that of J.T.; however, differences between the three treatments were more distinct (favoring accuracy and productivity monitoring). Percentage of on-task behavior re-

Figure 4. Number of mathematics problems completed during independent practice sessions for Mark and Tina across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

maintained high during the choice, fade, and follow-up phases.

Productivity

All subjects improved in at least one treatment condition. In contrast to previous studies, distinct differential effects were observed. Self-monitoring productivity resulted in an increased number of problems completed for all subjects.

Mark and Tina. Self-monitoring productivity resulted in immediate increases in the number of mathematics problems completed by Mark and Tina (Figure 4). The effects of attention and accuracy self-monitoring were similar for Mark. Self-monitoring attention proved superior for Tina, but the increase was only slightly above baseline levels. No improvement was observed for accuracy self-monitoring. The number of problems Mark completed decreased during the choice, fade, and follow-up phases; however, his levels remained ap-

Figure 5. Number of mathematics problems completed during independent practice sessions for Jose and Shawn across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

proximately 200% above baseline. Tina's productivity levels, by comparison, decreased sharply across these phases and approached baseline performance.

Jose and Shawn. Interpretation of Jose's results was complicated by considerable variation in baseline levels (see Figure 5). Although the mean number of problems completed increased for both productivity and attention self-monitoring, there was considerable overlap with baseline. Productivity self-monitoring was slightly more effective than attention self-monitoring, but differences emerged only after several sessions. Self-monitoring accuracy had no effect on the number of problems Jose completed. Self-monitoring productivity produced immediate and large increases in the number of problems Shawn completed, whereas attention and accuracy self-monitoring had little effect. Although Shawn showed a decrease in the number of problems completed during the choice, fade, and follow-

Figure 6. Number of mathematics problems completed during independent practice sessions for J.T. and Keith across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

Figure 7. Percentage of mathematics problems completed correctly during independent practice sessions for Mark and Tina across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

up phases, his performance remained above baseline levels.

J.T. and Keith. Only self-monitoring productivity affected the number of problems J.T. completed (Figure 6). During the choice, fade, and follow-up phases, the number of problems J.T. completed dropped but remained above baseline levels. Keith showed an immediate and large increase in the number of problems completed when self-monitoring productivity. By contrast, attention and accuracy self-monitoring had little effect upon his performance. Throughout the choice, fade, and follow-up phases, the number of problems Keith completed immediately decreased to baseline levels.

Accuracy

Percentage of problems completed correctly also improved for all students in at least one of the treatment conditions. However, the self-monitoring

procedures produced different effects across grade levels.

Mark and Tina. Self-monitoring productivity resulted in the greatest gains in the percentage of problems Mark completed correctly (Figure 7). Increases were also observed for attention self-monitoring, but there was considerable overlap with baseline. In contrast, self-monitoring accuracy did not affect the percentage of problems Mark completed correctly. During the choice phase, percentage correct also increased, followed by a descending trend during fade and follow-up. Tina's performance demonstrated no clear-cut differences among self-monitoring procedures during the first third of the self-monitoring phase. However, during the latter part, productivity and accuracy self-monitoring were consistently superior to attention self-monitoring, with productivity self-monitoring slightly better than accuracy self-monitoring. Percentage of

Figure 8. Percentage of mathematics problems completed correctly during independent practice sessions for Jose and Shawn across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

problems correct remained stable during the choice phase, but a small decreasing trend developed during the fade and follow-up conditions.

Jose and Shawn. Jose's performance stabilized during the latter part of the self-monitoring phase, and productivity self-monitoring produced the greatest effect on the percentage of problems correctly completed (Figure 8). This effect remained stable across choice, fade, and follow-up phases. Shawn's results are more difficult to interpret due to the high percentage of accuracy obtained during baseline. His percentages of problems correct during attention and productivity self-monitoring were indistinguishable, and percentage correct during self-monitoring accuracy was lower. However, during later sessions, self-monitoring productivity emerged as the superior intervention, with little difference between accuracy and attention self-monitoring.

Figure 9. Percentage of mathematics problems completed correctly during independent practice sessions for J.T. and Keith across experimental conditions. The carets appearing under observation sessions indicate when students began a new instructional objective in mathematics during independent practice.

Accuracy increased during the choice and fade phases, and remained stable during follow-up.

J.T. and Keith. For J.T., self-monitoring accuracy increased the percentage of problems correctly completed and was superior to both productivity and attention self-monitoring (see Figure 9). No differences were observed between attention or productivity self-monitoring, and neither produced an increase in the percentage of problems correct. J.T.'s performance remained constant during the choice, fade, and follow-up phases. Self-monitoring accuracy also was superior for Keith; however, in his case, differences between attention and productivity self-monitoring emerged. Self-monitoring attention proved more effective than self-monitoring productivity, which showed no improvement over baseline. Accuracy remained stable during the choice, fade, and follow-up phases.

DISCUSSION

Our results support the hypothesis that self-monitoring different target variables can differentially affect a student's academic productivity, engagement, and/or accuracy. In this section, we first compare our findings with those of previous studies. Next we examine the possibility that grade level affected the efficacy of target variables. Finally, we discuss some implications this research has for practice.

Our findings are consistent with previous research (e.g., Harris, 1986; Reid & Harris, *in press*) showing that (a) self-monitoring different target variables does not appear to differentially affect on-task behavior, (b) self-monitoring different target variables differentially affects academic productivity and/or accuracy, (c) self-monitoring academic outcomes is more effective than self-monitoring attention for academic productivity and accuracy, and (d) students prefer to monitor academic outcomes.

No pattern emerged among self-monitored target variables for on-task behavior. However, in contrast to the studies of Lloyd et al. (1989), Roberts and Nelson (1981), and Rooney et al. (1985), differences were obtained for academic performance. For fourth graders, productivity self-monitoring increased both the number of problems completed and percentage of problems correct; for sixth graders, accuracy self-monitoring increased percentage of problems correct, whereas productivity self-monitoring increased number of problems completed. These effects were large, persisted across new material, and were maintained for a 10-week period. Even though procedures used in self-monitoring productivity and accuracy were more time consuming than those used in self-monitoring attention, students completed more assignments when self-monitoring academic targets. Thus, students completed more assignments in less work time when self-monitoring either accuracy or productivity.

These results lend support to the superiority of self-monitoring productivity or accuracy. However, because accuracy of self-monitoring attention was not assessed, reactivity may have been adversely affected by inaccurate self-monitoring. For exam-

ple, Marshall (1983) reported that increasing the accuracy of self-monitoring enhanced reactivity for some students. However, researchers have reported significant reactivity when accuracy was low (e.g., Broden, Hall, & Mitts, 1971; Hallahan & Sapona, 1983), and in some instances, increased accuracy did not increase reactivity (Nelson, Lipinski, & Boykin, 1978). Although we cannot rule out the possibility that differential accuracy affected reactivity, we consider it unlikely because the reactive effects for on-task during self-monitoring attention were similar to the effects noted for the other target variables.

The absence of differences among target variables reported in earlier studies (e.g., Lloyd et al., 1989; Roberts & Nelson, 1981; Rooney et al., 1985) may have been due to brief intervals between self-monitoring conditions (e.g., 20 to 30 min). Thus, the 1-day interval in the present study and the 1-week interval used by Reid and Harris (*in press*) may have made it possible to isolate the effects of the different target variables. If so, the lack of differences among target variables reported in earlier studies may be due to carryover effects that masked distinctions (e.g., Hains & Baer, 1989). The carryover hypothesis seems plausible because both the procedures and academic tasks used in the present study were similar to those employed by Lloyd et al. (1989) and Roberts and Nelson (1981). For 2 subjects in the present study, nearly half the multiple schedule phase elapsed before differences emerged. Further, the other 4 students' performances continued to increase. Based on these findings, it is important that researchers investigating differential effects of self-monitoring procedures employ designs of sufficient duration.

In contrast to Lloyd et al. (1989), results for the fade and follow-up phases were mixed. Data for sixth graders (who self-monitored accuracy) were generally stable, although J.T. showed a slight descending trend for on-task during the fade condition. However, all fourth graders (who self-monitored productivity) showed decreases in on-task; Mark, Tina, and Shawn showed descending trends for productivity, and Mark and Tina showed descending trends for accuracy. However, with the

exception of Tina, all fourth-grade subjects' performances remained above baseline.

Slight decreases in performance during the fade phase have been previously reported (e.g., Hallahan, Marshall, & Lloyd, 1981). However, because the procedures used in this study were designed for fading self-monitoring attention, they may not be as effective for fading productivity or accuracy self-monitoring. That is, maintenance may require that cueing be provided for a longer period. However, because the fade and maintenance periods in this study were brief and trends were small in most instances, additional research is needed to support this conclusion.

Another difference between the present study and that of Lloyd *et al.* (1989) involves social validity. Although both studies used the same content, similar procedures, and common target variables, students' self-monitoring preferences differed. The students of Lloyd *et al.* preferred to self-monitor attention, but all students in the present study chose to self-monitor either academic accuracy or productivity. Harris (1986) and Reid and Harris (*in press*) also reported that their students preferred to self-monitor academic responding. It appears that students may have based their self-monitoring preferences on different criteria across studies. For example, Lloyd *et al.* (1989) noted that students reported productivity self-monitoring as more intrusive than attention self-monitoring. Therefore, they may have chosen to self-monitor attention simply because it required less effort. In contrast, studies reporting differential improvements in academic productivity and/or accuracy for productivity self-monitoring compared to attention self-monitoring found that students chose to self-monitor productivity over attention (Harris, 1986; Reid & Harris, *in press*). This finding may indicate that students base their preferences, at least to some degree, on the effects of self-monitoring on performance.

The results of the present study suggest that the effectiveness of self-monitoring may vary across age groups. The notion that development may influence the efficacy of self-monitoring has received some theoretical support. Researchers have found that

students' self-observations and reports of what behaviors constitute academic competence change as they mature (e.g., Paris & Byrnes, 1989; Paris & Newman, 1990; Skinner, Chapman, & Baltes, 1988), from emphasis on obedience, social conformity, teacher praise, and amount of work completed (Blumenfeld, Pintrich, Meece, & Wessels, 1982; Stipek & Tannatt, 1984) to evaluations such as quality of work completed and social comparisons (Stipek & MacIver, 1989). Changes in perceptions of academic competence could affect reactivity of self-monitoring. However, because the present study was not designed to assess the interaction between target variables and grade level, the possibility of differential effects is only suggestive and represents an area for future research.

Practical Implications

Although several reports have shown self-monitoring interventions to be effective and practical for classroom use (Hallahan & Sapona, 1983; Harris, 1986; Reid & Harris, *in press*), to date much of the research has examined students' performances in special education settings or has focused strictly on on-task behavior in a general education classroom (Blick & Test, 1987; Prater, Joy, Chilton, Temple, & Miller, 1991). The present study is the first to report effects of self-monitoring on academic productivity and accuracy for students with learning disabilities in a general education classroom. The finding that students can effectively and independently use self-monitoring in this setting suggests that these procedures can assist the integration of students with mild handicaps. Generalization also appears promising because the self-monitoring procedures used in the present study were taught in the special education resource room but were implemented in general education classrooms.

When given the choice, students selected the self-monitoring intervention that was most effective for them. The fourth graders chose to self-monitor productivity, which was the intervention that was most beneficial in terms of work output and accuracy, whereas the sixth graders chose accuracy

self-monitoring because it resulted in the most problems completed correctly. The finding that these students chose the most effective treatment could serve as a valuable guide for practitioners. However, further investigation is required before definitive conclusions can be drawn, because the stability of these choices remains unknown.

REFERENCES

- Blick, D. W., & Test, D. W. (1987). Effects of self-recording on high school students' on-task behavior. *Learning Disability Quarterly*, 10, 203-213.
- Blumenfeld, P. C., Pintrich, P. R., Meece, J., & Wessels, K. (1982). The formation and role of self-perceptions of ability in elementary classrooms. *The Elementary School Journal*, 82, 401-420.
- Broden, M., Hall, R. V., & Mitts, B. (1971). The effects of self-recording on the classroom behavior of two eighth-grade students. *Journal of Applied Behavior Analysis*, 4, 191-199.
- DiGangi, S. A., Maag, J. W., & Rutherford, R. B., Jr. (1991). Self-graphing of on-task behavior: Enhancing the reactive effects of self-monitoring on on-task behavior and academic performance. *Learning Disability Quarterly*, 14, 221-230.
- Federal Register*. (1977, August 23). Part II: Rules and regulations for amendments to Part B, Public Law 94-142, Education for All Handicapped Children Act of 1975.
- Friedling, C., & O'Leary, S. G. (1979). Effects of self-instructional training on 2nd and 3rd grade hyperactive children: A failure to replicate. *Journal of Applied Behavior Analysis*, 12, 211-219.
- Graden, J., Thurlow, M., & Ysseldyke, J. (1983). Instructional ecology and academic responding time for students at three levels of teacher-perceived competence. *Journal of Experimental Child Psychology*, 36, 241-256.
- Hains, A. H., & Baer, D. M. (1989). Interaction effects in multielement designs: Inevitable, desirable, and ignorable. *Journal of Applied Behavior Analysis*, 22, 57-69.
- Hallahan, D. P., Lloyd, J. W., Kosiewicz, M. M., Kauffman, J. M., & Graves, A. W. (1979). Self-monitoring of attention as a treatment for a learning disabled boy's off-task behavior. *Learning Disability Quarterly*, 2, 24-32.
- Hallahan, D. P., Marshall, K. J., & Lloyd, J. W. (1981). Self-recording during group instruction: Effects on attention to task. *Learning Disability Quarterly*, 4, 407-413.
- Hallahan, D. P., & Sapon, R. (1983). Self-monitoring of attention with learning disabled children: Past research and current issues. *Journal of Learning Disabilities*, 15, 616-620.
- Harris, K. R. (1986). Self-monitoring of attentional behavior versus self-monitoring of productivity: Effects on on-task behavior and academic response rate among learning disabled children. *Journal of Applied Behavior Analysis*, 19, 417-423.
- Hoge, R., & Andrews, D. (1987). Enhancing academic performance: Issues in target selection. *School Psychology Review*, 16, 228-238.
- Howell, K. W., & Morehead, M. K. (1987). *Curriculum-based evaluation for special and remedial education*. Columbus, OH: Merrill.
- Howell, K. W., Zucker, S. H., & Morehead, M. K. (1982). *Multilevel academic skills inventory: Math*. San Antonio, TX: Psychological Corp.
- Howell, K. W., Zucker, S. H., & Morehead, M. K. (1985). *MAST: Multilevel academic survey test*. San Antonio, TX: Psychological Corp.
- Klein, R. D. (1979). Modifying academic performance in the grade school classroom. In M. Hersen, R. M. Eisler, & P. M. Miller (Eds.), *Progress in behavior modification* (Vol. 8, pp. 293-321). New York: Plenum.
- Lentz, F. E. (1988). On-task behavior, academic performance, and classroom disruptions: Untangling the target selection problem in classroom interventions. *School Psychology Review*, 17, 243-257.
- Lloyd, J. W., Bateman, D. F., Landrum, T. J., & Hallahan, D. P. (1989). Self-recording of attention versus productivity. *Journal of Applied Behavior Analysis*, 22, 315-323.
- Lloyd, J. W., & Landrum, T. J. (1990). Self-recording of attending to task: Treatment components and generalization of effects. In T. E. Scruggs & B. Y. L. Wong (Eds.), *Intervention research in learning disabilities* (pp. 235-262). New York: Springer-Verlag.
- Mace, F. C., Brown, D. K., & West, B. J. (1987). Behavioral self-management in education. In C. A. Maher & J. E. Zins (Eds.), *Psychoeducational interventions in the schools* (pp. 160-176). New York: Pergamon.
- Mace, F. C., & Kratochwill, T. R. (1988). Self-monitoring. In J. C. Witt, S. N. Elliott, & F. M. Gresham (Eds.), *Handbook of behavior therapy in education* (pp. 489-522). New York: Plenum.
- Marshall, K. J. (1983). *The effects of training to increase self-monitoring accuracy on the attention-to-task of learning-disabled children*. Unpublished doctoral dissertation, University of Virginia.
- Nelson, R. O., Lipinski, D. P., & Boykin, A. R. (1978). The effects of self-recorders' training and the obtrusiveness of the self-recording device on the accuracy and reactivity of self-monitoring. *Behavior Therapy*, 9, 200-208.
- Paris, S. G., & Byrnes, J. P. (1989). The constructivist approach to self-regulation and learning in the classroom. In B. J. Zimmerman & D. H. Schunk (Eds.), *Self-regulated learning and academic achievement* (pp. 169-200). New York: Springer-Verlag.
- Paris, S. G., & Newman, R. S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist*, 25, 87-102.
- Petersen, P. L., & Swing, S. R. (1982). Beyond time on task: Students' reports of their growth processes during

- classroom instruction. *The Elementary School Journal*, 82, 481-491.
- Prater, M. A., Joy, R., Chilman, B., Temple, J., & Miller, S. R. (1991). Self-monitoring of on-task behavior by adolescents with learning disabilities. *Learning Disabilities Quarterly*, 14, 164-177.
- Reid, R., & Harris, K. R. (in press). Self-monitoring of attention versus self-monitoring of performance: Effects on attention and academic performance. *Exceptional Children*.
- Roberts, R. N., & Nelson, R. O. (1981). The effects of self-monitoring on children's classroom behavior. *Child Behavior Therapy*, 3, 105-120.
- Rooney, K. J., Followay, E., & Hallahan, D. P. (1985). The use of self-monitoring procedures with low IQ learning disabled students. *Journal of Learning Disabilities*, 18, 384-389.
- Ruggles, T., & LeBlanc, J. (1985). Behavior analysis procedures in classroom teaching. In A. Bellack, M. Hersen, & A. Kazdin (Eds.), *International handbook of behavior modification and therapy* (pp. 353-390). New York: Plenum.
- Rusch, F. R., & Kazdin, A. E. (1981). Toward a methodology of withdrawal designs for the assessment of response maintenance. *Journal of Applied Behavior Analysis*, 14, 131-140.
- Salvia, J., & Hughes, C. (1990). *Curriculum-based assessment: Testing what is taught*. New York: Macmillan.
- Skinner, E. A., Chapman, M., & Baltes, P. B. (1988). Control, means-ends, and agency beliefs: A new conceptualization and its measurement during childhood. *Journal of Personality and Social Psychology*, 54, 117-133.
- Snider, V. (1987). Use of self-monitoring of attention with LD students: Research and application. *Learning Disabilities Quarterly*, 10, 139-151.
- Stipek, D., & MacIver, D. (1989). Developmental change in children's assessment of intellectual competence. *Child Development*, 60, 521-538.
- Stipek, D. J., & Tannatt, L. M. (1984). Children's judgments of their own and their peers' academic competence. *Journal of Educational Psychology*, 76, 75-84.
- Thomson, C., Holmberg, M., & Baer, D. M. (1974). A brief report on a comparison of time sampling procedures. *Journal of Applied Behavior Analysis*, 7, 623-626.
- Treiber, F. A., & Lahey, B. B. (1983). Toward a behavioral model of academic remediation with learning disabled children. *Journal of Learning Disabilities*, 16, 111-116.

Received May 26, 1992

Initial editorial decision August 26, 1992

Revisions received September 28, 1992; January 12, 1993; March 22, 1993

Final acceptance April 6, 1993

Action Editor, F. Charles Mace

APPENDIX A

Percentage of On-Task Behavior Across Experimental Conditions

Subject		Baseline	Alternating procedures				Fade		Follow-up
			Productivity	Accuracy	Attention	Choice	No tone	No sheet	
Mark	M	19	48.53	33.31	38.36	56.5	47	48.33	41
	SD	2.24	5.20	5.51	6.64	1.12	3.56	6.18	1
	Median	19	48	33	38	56.50	49	45	41
	Range	16-22	41-58	26-46	26-53	55-58	42-50	43-57	40-42
Tina	M	33.4	48.64	39.91	43.69	48.60	45.67	44	35
	SD	5.39	4.24	4.6	5.33	2.87	2.06	1.73	0
	Median	33	49.50	40	42	50	46	43	35
	Range	26-41	40-55	30-47	36-55	43-51	43-48	39-50	35
Jose	M	17.8	50.56	39.08	48.4	42.75	40.33	41.5	41.5
	SD	6.01	3.39	6.05	6.91	1.64	.47	1.5	1.5
	Median	16	51.5	40	50	43.5	40	41.5	41.5
	Range	10-28	41-55	29-50	39-58	40-44	40-41	40-43	40-43
Shawn	M	31.7	46.08	42.73	42.38	42	40	39.67	43.5
	SD	6.81	4.57	5.14	6.91	2.45	0	1.7	.5
	Median	32	47.50	42	43	42	40	39	43.5
	Range	17-40	36-52	30-50	29-53	39-46	40-40	40-43	40-43

APPENDIX A

(Continued)

Subject		Baseline	Alternating procedures				Fade		Follow-up
			Productivity	Accuracy	Attention	Choice	No tone	No sheet	
J.T.	<i>M</i>	43.40	51.75	56.08	44.80	56.80	55	51	53.5
	<i>SD</i>	4.76	3.65	3.07	4.92	1.17	1.63	0.82	1.5
	Median	45	51.50	57	46	57	55	51	53.5
	Range	36–49	45–58	50–60	32–52	55–58	53–57	50–52	52–55
Keith	<i>M</i>	40	47.15	52	42.61	50.8	51.33	50.33	50
	<i>SD</i>	4.47	7.29	5.06	4.6	4.26	.94	2.06	2
	Median	39	48	52.50	42	52	52	50	50
	Range	33–48	32–55	39–58	36–52	43–55	50–52	48–53	48–52

APPENDIX B

Number of Problems Completed Across Experimental Conditions

Subject		Baseline	Alternating procedures				Fade		
			Productivity	Accuracy	Attention	Choice	No tone	No sheet	Follow-up
Mark	<i>M</i>	5.5	14.69	5.38	9.64	16.5	16.33	15	12.5
	<i>SD</i>	1.12	3.51	1.33	2.12	.5	1.7	0	.5
	Median	5.5	16	6	9	16.5	17	15	12.5
	Range	4–7	6–20	3–7	7–15	16–17	14–18	15	12–13
Tina	<i>M</i>	8.6	23.29	11.09	14.38	21.25	17.67	14.33	14
	<i>SD</i>	2.11	2.01	2.43	2.06	.83	2.49	1.7	0
	Median	8.5	23	11	14	21.5	17	15	14
	Range	5–12	20–27	7–15	1–19	20–22	15–21	12–16	14
Jose	<i>M</i>	7	15.94	9.92	13.4	15	13.67	14.5	16
	<i>SD</i>	4.56	2.13	2.75	2.03	1.87	1.7	.5	1
	Median	5	16	10	13	15.5	13	14.5	16
	Range	3–15	10–19	5–14	10–17	12–17	12–16	14–15	15–17
Shawn	<i>M</i>	11.4	21.92	13.73	14.88	18	16	14.33	17
	<i>SD</i>	2.8	2.84	4	2.57	2.28	1	1.7	0
	Median	11	22	12	14.5	17	16	15	17
	Range	6–16	18–27	11–26	11–23	16–22	15–17	12–16	17
J.T.	<i>M</i>	3.6	9.69	5	5.71	6.8	6.67	7.67	9.5
	<i>SD</i>	.8	2.59	1.29	.70	.75	.94	3.27	.5
	Median	3	10	5	6	7	6	9	9.5
	Range	3–5	3–14	3–7	5–7	6–8	6–8	5–9	9–10
Keith	<i>M</i>	10.89	28	12.9	12.38	13.4	13	14.33	15.5
	<i>SD</i>	3.35	2.77	1.51	1.73	1.50	1.63	2.62	.5
	Median	10	28	13	13	13	13	13	15.5
	Range	5–17	22–32	10–15	9–15	11–15	11–15	12–18	15–16

APPENDIX C
Percentage of Problems Completed Correctly Across Experimental Conditions

Subject		Alternating procedures					Fade		
		Baseline	Produc- tivity	Accuracy	Attention	Choice	No tone	No sheet	Follow-up
Mark	<i>M</i>	40.25	73	43.85	55.71	93.75	88.33	82	71
	<i>SD</i>	13.06	9.2	13.3	8.45	4.26	8.26	2.83	5
	Median	38	76	42	55	93.5	83	80	71
	Range	25–60	50–88	20–71	37–70	88–100	82–100	80–86	66–76
Tina	<i>M</i>	45.4	71.86	65.64	57.54	76.25	80	73.67	64
	<i>SD</i>	10.57	10.37	10.81	9.85	3.27	9.93	5.79	0
	Median	46.5	75	70	57	77	86	75	64
	Range	25–60	54–86	36–76	42–76	71–80	66–88	66–80	64
Jose	<i>M</i>	28.2	69	45.33	46.73	83.5	82.67	72	87
	<i>SD</i>	19.53	16.84	21.21	13.57	5.85	1.25	1	1
	Median	33	70	51	46	83.5	82.67	72	87
	Range	0–55	20–88	10–70	20–80	76–91	81–84	71–73	86–88
Shawn	<i>M</i>	56.2	73	55.27	62.44	81.2	93.5	89	85
	<i>SD</i>	16.81	7.57	13.5	13.63	5.74	5	8.04	3
	Median	50	75.5	58	62	81	93.5	86	85
	Range	30–80	59–85	33–72	25–85	73–88	93–94	81–100	82–88
J.T.	<i>M</i>	31.2	32.5	83.67	40.5	91	90	96	90
	<i>SD</i>	16.8	19.09	13.8	14.87	7.46	7.26	5.66	10
	Median	33	26	83	40	87	87	100	90
	Range	0–50	14–100	60–100	20–66	83–100	83–100	88–100	80–100
Keith	<i>M</i>	32.89	23.38	85.3	42.61	92.8	87.33	91.67	80.5
	<i>SD</i>	18.38	6.44	17.32	13.03	6.27	9.84	6.95	5.5
	Median	40	23	89	42	92	86	92	80.5
	Range	0–66	14–37	53–100	36–52	86–100	76–100	83–100	75–86