STRATEGIC NOTE-TAKING FOR MIDDLE-SCHOOL STUDENTS WITH LEARNING DISABILITIES IN SCIENCE CLASSES

Joseph R. Boyle

Abstract. While today’s teachers use a variety of teaching methods in middle-school science classes, lectures and note-taking still comprise a major portion of students’ class time. To be successful in these classes, middle-school students need effective listening and note-taking skills. Students with learning disabilities (LD) are poor note-takers, which negatively impacts their academic performance. This investigation sought to examine the effects of strategic note-taking on the recall and comprehension of middle-school students with LD. Forty students with LD were randomly assigned to either an experimental or a control group. Using strategic note-taking, students in the experimental group were taught to record notes independently while viewing a videotaped science lecture. Students who were taught strategic note-taking scored significantly higher on measures of immediate free recall, long-term free recall, comprehension, and number of lecture points and words recorded in their notes than students in a control group who used conventional note-taking. The limitations of the research and implications of this technique for classroom application are discussed.

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Since the Individuals with Disabilities Education Act (IDEA) was amended in 1997, and subsequently in 2004, schools have been required to provide students with disabilities access to the general education curriculum and instruction in grade-level concepts from the content-area classes such as science, social studies, and math (Gersten, Baker, Smith-Johnson, Dimino, & Petersen, 2006). Access to the curriculum goes beyond mere placement with same-aged peers. In fact, IDEA mandates that students with disabilities are to be involved in and advance within the general education curriculum (Deshler et al., 2001; Soukup, Wehmeyer, Bashinski, & Bovaird, 2007). The belief is that meaningful access to the general education curriculum will allow students to learn core content and, in the process, pass state tests (Deshler, Schumaker, Bui, & Vernon, 2006). In order for this to occur, students with learning disabilities (LD) need to learn new strategies to become engaged with the content, particularly when teachers present content through traditional means, such as lectures and discussions.

Learning through traditional teaching formats (e.g., lectures) in content areas such as science entails using effective listening and note-taking skills. A lack of these skills frequently means that students with LD miss out on important content (Scruggs, Mastropieri,
Berkeley, & Graetz, in press; Stringfellow & Miller, 2005). While today’s teachers use a variety of teaching methods in content areas, lecture and note-taking still comprise a major portion of students’ class time. For example, one recent investigation found that 79% of content-area teachers reported that they “regularly use” or “mostly use” lectures during their teaching (Vogler, 2006). Similarly, in a national survey of more than 500 middle-school science teachers, respondents reported that nearly two thirds of their science classes involved students listening to and taking notes during lectures (Fulp, 2002). Similar results have been found in mathematics, in that middle-school teachers report that lectures and note-taking occur in 80% of their math classes and that they take place, on average, 36% of the time in these classes (Hudson, McMahon, & Overstreet, 2002).

In most science classes, teachers rely on textbooks that are aligned with state standards to teach concepts, facts, and vocabulary (Huber & Moore, 2002; Scruggs, Mastropieri, & McDuffie, 2007). And it is from this textbook-driven curriculum, which is comprised of numerous science concepts, heavily laden vocabulary, and related facts (Cawley, Hayden, Cade, & Baker-Kroczynski, 2002; Scruggs et al., 2007; Scruggs, Mastropieri, & Oklo, 2008), that teachers develop daily class lectures and lessons (Harniss, Dickson, Kinder, & Hollenbeck, 2001).

In turn, the content of lectures often forms the basis for teacher-made tests and quizzes. Putnam, Deshler, and Schumaker (1993) found that teachers’ lectures were the major source of information (upon which test questions were based) (p. 340). In addition, teachers reported that in their secondary content classes almost half of a student’s grade was derived from students’ performance on these tests (Putnam et al., 1993).

In order for students with LD to be successful in these classes, they must learn from lectures that move at a quick pace and are comprised of many facts and vocabulary (Scruggs et al., in press; Suritsky, 1992; Vaughn, Schumm, & Shay, 1994). Even though learning from lectures is difficult for students with LD (Boyle, 2009; Hughes & Suritsky, 1994; Stringfellow & Miller, 2005; Suritsky, 1992), general education teachers have acknowledged that all students must be able to take notes and learn from lectures in order to do well in their classes (Suritsky & Hughes, 1996). Researchers (Knowlton, 1983; Schumaker & Deshler, 1984) have found that middle- and high-school teachers have ranked note-taking and listening skills as some of the top skills that students should have in their classes, and others (Snyder & Bambara, 1997) have reported that similar survival skills are needed in today’s secondary content area classrooms.

Despite the importance of being able to record notes effectively in content-area classes, students with LD are poor note-takers. One recent study (Boyle, 2009) found that middle-school students with LD recorded only 13% of the total lectures points (TLP) for a science lecture, compared to students with no learning disabilities (NLD), who recorded 25% of the TLP. Furthermore, even when provided with cued lecture points (CLP) (i.e., emphasis and organizational cues) throughout the lecture, middle-school students with LD recorded only 18% of the CLP, compared to students with NLD, who recorded 43% of the CLP. This study additionally found that CLP was moderately correlated (.53) with students’ test performance.

Recording cued notes is important for students because teachers often use emphasis cues (e.g., “You should remember that ....”) immediately preceding a salient lecture point (e.g., “... in Paraguay, burrowing toads form a cocoon around themselves to prevent water loss ....”) to call attention to its importance. Further, teachers expect that all students record this cued lecture point in their notes (Titsworth & Kiewra, 2004).

A second type of cued lecture point, an organizational cue (e.g., “There are six adaptation strategies used by toads during the dry season.”), helps students by providing a framework for organizing certain aspects of lecture content and assists students in discerning important from less important lecture content (Titsworth, 2001a, 2001b). Researchers believe that organizational cues help students process information more efficiently through a natural “chunking” process, thereby reducing the load on working memory (Cowan, 1995; Gathercole, Durling, Evans, Jeffcock, & Stone, 2007).

Regardless of the type of lecture cue, these cues increase the amount of notes that students record and, ultimately, increase their achievement on comprehension and recall measures (Titsworth, 2001a, 2001b; Titsworth & Kiewra, 2004). Hence, when these cues are presented in lectures, all students should record the cued lecture points in their notes.

In studies on the problems that students with LD experience during class lectures, researchers have shown that students with LD demonstrate both poor listening skills and poor note-taking skills. For example, Hughes and Suritsky (1994) found significant differences among college students with LD and NLD who recorded notes during a lecture. Their results showed that college students with LD who viewed a videotaped lecture while recording notes recorded fewer cued lecture points, fewer non-cued lecture points, and, overall, fewer total lecture points. Specifically, college students with LD recorded only 36% of cued lecture points, whereas students with NLD recorded 56% of the lecturer’s notes. Further, students with LD recorded 50% of overall...
lecture information units compared to 60% for NLD students.

In terms of listening during lectures, Ward-Lonergan, Lilies, and Anderson (1998, 1999) performed two studies that examined the effects of listening skills during lectures. Although student note-taking was not involved, these studies illustrate the learning problems that students with LD encounter during lectures. In the first study, Ward-Lonergan et al. (1998) compared the performance of middle-school students with language learning disabilities (LLD) with that of students with NLD who watched two 5-minute lectures (i.e., comparison versus causation) on social studies. Results showed that students with NLD performed significantly better than students with LLD on both types of lectures, regardless of the type of question (i.e., literal versus inferential questions).

In a second study, similar to the first, Ward-Lonergan et al. (1999) again compared the performance of middle-school students with LLD and with NLD who viewed two 5-minute social studies lectures using a comparison or causation format, but with different content. In this study, students viewed two lectures and, after each lecture, verbally retold the content of the lecture while being audiotaped. Students' retells were assessed by counting T-units. Students with NLD recalled significantly more information than students with LLD on all of the measures in terms of linguistic productivity (number of T-units, number of subordinate clauses, and percentage of lecture points), syntactic complexity (number of subordinate clauses per T-unit), and efficiency (number of T-units per second, number of lecture components per T-unit, and number of lecture components per second).

The ramifications of ineffective listening and note-taking skills are often detrimental to student learning and recall, particularly for students with LD. To succeed in middle-school science classes, these students must learn these essential skills (Cawley, Kahn, & Tedesco, 1989; Laidlaw, Skok, & McLaughlin, 1993; Ward-Lonergan et al., 1998, 1999).

Laidlaw et al. (1993) found that when students do not record notes, they perform more poorly on tests and quizzes (students' scores averaged 44%) than when they do record notes during lectures (students' scores increased to an average of 79%). Likewise, middle-school students with NLD who recorded "more notes" (i.e., ideas and words) outperformed students who recorded fewer notes on tests of recall and recognition (Risch & Kiewra, 1990).

For students with LD who exhibit poor listening skills, note-taking has been suggested as one method to assist them during lectures that are auditory in nature (Ward-Lonergan et al., 1998, 1999). Of the note-taking techniques relevant for K-12 students with disabilities for use during lectures, only two research-based techniques are available in the literature: guided notes and strategic note-taking.

Guided notes have been used for students with disabilities (Lazarus, 1991, 1993: Study 1; Patterson, 2005; Sweeney et al., 1999) in K-12 school settings during lectures. The majority of these studies found that once K-12 school students with mild disabilities were trained to use guided notes, they exhibited greater gains on tests (over baseline periods), and often the greatest gains were found when guided notes were used with a short review or study period.

The second note-taking technique, strategic note-taking (Boyle & Weishaar, 2001), has been found to be effective for high-school students with mild disabilities. When these students were trained to use strategic note-taking to record notes of videotaped lectures, they outperformed control subjects who used conventional note-taking techniques on immediate free recall, long-term recall, quiz performance (i.e., comprehension), and total recorded notes (Boyle & Weishaar, 2001). To date, only two studies (Boyle & Weishaar, 2001; Patterson, 2005) have sought to examine the effects of a note-taking technique on student learning during science lectures.

While guided notes are effective for students with disabilities, preparing guided notes by reviewing the content of the lecture and then transcribing it in guided-note form for students is very time intensive for teachers. Even though general education teachers expect students with LD to meet the same evaluative criteria as NLD students (Schumm et al., 1995), researchers found that general education science and social studies teachers were often reluctant to make changes in their teaching or presentation mode for students with mild disabilities (McIntosh, Vaughn, Schumm, Haager, & Lee, 1993; Schumm & Vaughn, 1991, 1995) and were concerned that making adaptations in their classes for these students would come at the expense of students without disabilities (Vaughn, Schumm, & Kouzakanani, 1993). In fact, most general education teachers have to cover vast quantities of information at a relatively quick pace in order for students to pass end-of-the-year state tests and smoothly transition to more advanced courses (Deshler et al., 2006; Schumm et al., 1995), making it difficult to find the time to make and use adaptations for students with disabilities, such as guided notes.

A more efficient approach to note-taking would be to teach students with disabilities note-taking strategies and techniques that they could use independent of teacher assistance. One such independent approach, strategic note-taking, initially might be time intensive.
to teach to students (typically two class sessions); however, in the long run, a technique such as this makes students more independent learners and may generalize to multiple settings, such as other general education content-area classes, making the initial time investment worthwhile. Furthermore, an independent approach would not require general education teachers to make many adjustments in their lecture style or content nor add preparation to their workload. Unlike guided notes, which must be prepared in advance of class, strategic note-taking offers a note-taking technique that can be used with different types of science content (earth science and life science) and with no teacher preparation. Finally, because note-taking skills are used in secondary, postsecondary, and even work environments, it is essential that students learn how to record notes and not have to rely on others to record notes for them. Strategic note-taking meets these goals by providing students with a basic set of skills that they can use in a variety of settings and with different types of lecture content.

Given the paucity of literature on research-based note-taking techniques for school-age students with LD, the current study sought to extend the research by assessing the effects of strategic note-taking on the performance of middle-school students with LD.

Specifically, the study sought to address the following four research questions:
1. Will students who used strategic note-taking record more notes overall?
2. Will students who used strategic note-taking perform better on recall measures and a comprehension test?

Table 1

<table>
<thead>
<tr>
<th>Characteristics of Participants</th>
<th>Control Group</th>
<th>Experimental Group</th>
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<tbody>
<tr>
<td></td>
<td>(N = 20)</td>
<td>(N = 20)</td>
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<tr>
<td>Gender:</td>
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<tr>
<td>Male</td>
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<tr>
<td>Female</td>
<td>9</td>
<td>9</td>
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<tr>
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<td>3</td>
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<tr>
<td>European-American</td>
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<td>15</td>
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<tr>
<td>Hispanic-American</td>
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<td>0</td>
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<tr>
<td>Asian-American</td>
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<td>2</td>
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<tr>
<td>IQ Scores:</td>
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<tr>
<td>Mean Full Scale (SD)</td>
<td>103.90</td>
<td>99.95</td>
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<td></td>
<td>(11.39)</td>
<td>(12.42)</td>
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<tr>
<td>Achievement Test:</td>
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<tr>
<td>Mean Reading (SD)</td>
<td>93.60</td>
<td>91.23</td>
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<td></td>
<td>(12.16)</td>
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<td>Mean Written Language (SD)</td>
<td>96.57</td>
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<td>(12.93)</td>
<td>(10.06)</td>
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<td>Mean Mathematics (SD)</td>
<td>85.75</td>
<td>94.86</td>
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<td></td>
<td>(15.30)</td>
<td>(8.82)</td>
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<td>Writing Sample:</td>
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<tr>
<td>Mean LPM (SD)</td>
<td>68.75</td>
<td>67.15</td>
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<td></td>
<td>(16.43)</td>
<td>(20.32)</td>
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</table>
3. Will students who used strategic note-taking record more cued lecture points?
4. Will students who used strategic note-taking recall more cued lecture points?

**METHOD**

**Participants and Setting**

Using an experimental group-control design (Kerlinger, 1986), 40 students with LD in sixth through eighth grade were randomly assigned to either a control or an experimental group, each group being comprised of 11 males and 9 females (see Table 1). The composition of the group was 70% European-American, 12.5% Hispanic-American, 12.5% African-American, and 5% Asian-American. The subjects, whose ages ranged from 11.5 to 15.7, were drawn from seven science classes at two middle schools.

All of the students were identified as having a specific learning disability and were determined eligible for services by their respective school districts through testing that used severe discrepancy methodology (i.e., intelligence and academic achievement). Each district’s eligibility policies closely followed state and federal guidelines. Using the state definition of LD, students were required to have an average or above-average IQ score and difficulties in one or more of the following areas: oral expression, listening comprehension, written expression, basic reading skill, reading fluency skills, reading comprehension, mathematics calculation, or mathematics problem solving.

Students with LD were assessed on IQ using either the Wechsler Intelligence Scale for Children III or IV (Wechsler, 1991, 2003), and their achievement was assessed using the Woodcock Johnson Tests of Achievement III (Woodcock, McGrew, & Mather, 2001) or the Wechsler Individual Achievement Test-II (Wechsler, 2001). On IQ tests (e.g., WISC-III or WISC-IV), the mean full scale standard for the group was 102.

On the achievement tests, the average standard score in reading was 92.5, 95.3 in written language, and 90.0 in mathematics. None of the students had any reported history in their records of hearing impairments, visual impairments, physical impairments, or emotional disorders.

The students attended one of two middle schools (with approximately 537 and 625 students, respectively) located near a large metropolitan city in the Mid-Atlantic region of the United States. All of the students were enrolled in middle-school science classes, and the research took place in these classes with both the general education and the special education teacher present in the room. The teachers did not participate in any component of the study. Rather, the investigator carried out all of the training and data collection.

The investigator initially administered a 3-minute writing measure to assess how fast students with LD could write with little or no mental effort (Hughes & Suritsky, 1994). This measure was used as a pretreatment measure. This same type of writing measure has been used in other studies (Boyle & Weishaar, 2001; Hughes & Suritsky, 1994; Lee, Lan, Hamman, & Hendricks, 2008) and is similar to other 3-minute writing tasks that serve as measures of writing speed (Ganske, Noell, VanDerHeyden, Naquin, & Slider, 2002).

Letters-per-minute probes have been associated with writing proficiency (Marston, 1989) and have been suggested as one measure of writing fluency (Howell & Nolte, 2000). Feverly (2006) claimed that among students with fast handwriting speed, the load on working memory lessens, thereby enabling them to focus on other aspects of writing and note-taking.

In addition to random sampling of students into control and experimental groups, a t test was conducted to ensure that both groups were equivalent. The results of the initial analyses showed no significant differences between the two groups on the 3-minute writing task, nor were there any significant differences between the two groups on IQ test scores.

**Materials**

Two videotaped lectures were used, one for training (i.e., Frogs and Toads) and one for the testing session (i.e., Sican Metal Workers). Videotaped lectures offer several advantages over live lectures. The videotaped lecture for the testing session controlled for extraneous variables (e.g., pacing, intonation, pauses) that might have been present if the lecture had been presented “live” to multiple groups of students; similarly, the videotaped lecture for the training session allowed for a second presentation during the training (described in detail in the procedures section).

In addition to controlling for students’ prior knowledge, and because the focus of the lecture was science, the testing session topic was drawn from a Scientific American article entitled “Sican Metal Workers.” The content of the testing lecture described how craftsmen of the Middle Sican era created metal alloys for use in religious ceremonies. This content was selected on the presumption that the information would not be familiar to the participants. In fact, the topic and content is not a learning standard listed in the state standards, and the science teachers whose students participated in the study confirmed that students had not been exposed to this topic.

Videotaped lectures were presented to students on a 25-inch color television monitor. The videotaped lecture was 23 minutes long and was presented at an average rate of 110 words per minute (WPM). This WPM rate
falls within the middle range of “rates of presentation” in videotaped lectures that have been used in past research: 75 WPM (Bretzing, Kulhavy, & Caterino, 1987), 100 WPM (DiVesta & Gray, 1972), 100 WPM (Risch & Kiewra, 1990), 108 WPM (Suritsky & Hughes, 1994), 109 WPM (Boyle, 2009), 110 WPM (Boyle & Weishaar, 2001), 120 & 122 WPM (Titsworth, 2004), and 133 WPM (Ward-Lonergan et al., 1998, 1999).

The videotaped lectures (i.e., training and testing) simulated a typical science lecture in that they were auditory in nature, with only the title of the lecture written on the board. Each lecture was read from a script that contained both CLP and noncued lecture points (NCLP). Each CLP used one of two types of cues: emphasis cue or organizational cue (Hughes & Suritsky, 1994; Scerbo, Warm, Dember, & Grasha, 1992; Titsworth & Kiewra, 2004). The first type of cue, an emphasis cue (e.g., “It is important to remember”), preceded an important lecture point and served to alert students to this information. The second type of cue, an organizational cue (e.g., “Craftsmen created three types of objects using gold alloys.”), served as a framework upon which students organize lecture details.

Of particular interest was how many CLP and total lecture points (TLP) (CLP plus NCLP = TLP) students would record in their notes during the testing session of the “Sican Metal Worker” lecture. This lecture contained 17 CLP plus 43 NCLP, totaling 60 TLP. Titsworth and Kiewra (2004) pointed out that lecture cues serve three key purposes: stimulating student interest, signaling the importance of lecture content, and signaling the organization of subsequent lecture ideas. Perhaps most important, studies have shown that when cues are used in lectures, NLD students increase their note-taking and subsequent achievement (Maddox & Hoole, 1975; Scerbo et al., 1997; Titsworth, 2001a, 2001b, 2004; Titsworth & Kiewra, 2004). Hence, while it is important to examine how many TLP students record in their notes during the lecture, it is also critical to examine how many CLP they record.

Dependent Variables

Four dependent variables were used to assess the effectiveness of strategic note-taking: an immediate free recall (IFR) measure, a long-term free recall (LFR) measure, a test that resulted in a test score (TS), and students’ notes. Similar measures have been used to assess students’ productivity and performance from lectures (Kiewra et al., 1995; O’Donnell & Dansereau, 1993; Rickards, Fajen, Sullivan, & Gillespie, 1997; Risch & Kiewra, 1990) and will help demonstrate the effectiveness of CLP and TLP recorded and recalled.

The dependent variables were analyzed in several ways: CLP, NCLP, TLP, and total words (TW) across notes and recall measures, as well as test score (TS). Students’ notes and recall measures were examined for CLP and NCLP based upon how many individual lecture points (LP) were present in the notes. CLP and NCLP were added together to get TLP. A lecture point found in notes was defined as an idea or a block of information from the lecture, with a short clause or phrase accepted as the minimum to be counted as a lecture point. Students’ LP were compared to the script from the lecture, and one point was awarded for each accurate lecture point. A similar criterion has been used in past note-taking studies that examined CLP and NCLP in students’ notes (Hughes & Suritsky, 1994; Titsworth & Kiewra, 2004). In this study students’ notes and recall measures were first assessed for CLP and then assessed a second time for NCLP. Assessing notes according to LP (or idea units) is a common procedure that has been used in previous research (Brown, 2005; Fisher & Harris, 1973; Hughes & Suritsky, 1994; Kiewra et al., 1995; O’Donnell & Dansereau, 1993; Risch & Kiewra, 1990).

Students’ notes and recall measures were also counted to derive the total number of words present. A measure of productivity, the same procedure has been used in past research (Boyle & Weishaar, 2001; Hartley & Marshall, 1974). Finally, student learning was assessed using a 15-point multiple-choice test. Students’ TS was used to assess how performance would vary between the two groups (i.e., experimental vs. control) after students recorded lecture notes.

Interrater Reliability

An independent rater (i.e., a graduate student in education) who was unaware of which students were in the experimental or the control group scored all notes, recall measures, and the test. In addition, one third of the students’ notes, recall measures, and tests were rescored by a second rater in the same manner as the first. Interobserver agreement for each measure was assessed by dividing agreements by agreements plus disagreements.

Students’ notes. Immediately after the videotape concluded and students finished recording their notes, all students’ notes were collected prior to administering the recall measure or the test. An independent rater scored all IFR measures for CLP, NCLP, TLP and TW. Using the IFR measure, a second rater randomly selected one third of the IFR measures and scored each in the same manner as the first rater. Interrater reliability for IFR was calculated to be .96 for CLP, .94 for NCLP, .95 for TLP, and .98 for TW.

Immediate free recall. An immediate free recall measure was administered promptly after students viewed the videotape to assess their knowledge about the lec-
**Figure 1.** Abbreviated version of strategic note-taking paper.

<table>
<thead>
<tr>
<th>Strategic Note-Taking Form</th>
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<tbody>
<tr>
<td>What is today's topic?</td>
</tr>
<tr>
<td>Describe what you know about the topic.</td>
</tr>
<tr>
<td><em>(Fill in this information before the lecture begins)</em></td>
</tr>
<tr>
<td><strong>When the lecture begins, use these pages to take notes.</strong></td>
</tr>
<tr>
<td>Today's topic?</td>
</tr>
<tr>
<td>Name 3 to 6 main points with details of today's topic as they are being discussed.</td>
</tr>
<tr>
<td>Summary – Quickly describe how the ideas are related.</td>
</tr>
<tr>
<td>New Vocabulary or Terms:</td>
</tr>
</tbody>
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<tr>
<td>Page 1</td>
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<td>Page 2</td>
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<tr>
<td>Page X</td>
</tr>
<tr>
<td>Last Page</td>
</tr>
</tbody>
</table>

**At End of Lecture**

Write five important lecture points and describe the details of each lecture point:

1.
2.
3.
4.
5.

Figure 2. Strategic note-taking strategy.

During the Lecture Listen for CUES

- **C - Cluster** - Cluster together 3 to 6 main points of the lecture
- **U - Use** - Use teacher cues to record ideas
  1. Number Cues -  
     ex. *There are six parts to the cell*
  2. Importance Cues -  
     ex. *This is really important to remember...*
- **E - Enter** - Enter important vocabulary
- **S - Summarize** - Summarize quickly and whenever possible

ture topic. Upon completing the videotape, students’ notes were collected, and students were told to use a blank piece of paper provided to write down as many facts, vocabulary, and lecture ideas as they could within a 5-minute time period.

An independent rater scored all IFR measures for CLP, NCLP, TLP, and TW. Using the IFR measure, a second rater randomly selected one third of the IFR measures and scored each in the same manner as the first rater. Interrater reliability for IFR was calculated to be .96 for CLP, .96 for NCLP, .96 for TLP, and .99 for TW.

**Long-term free recall.** Similar to the IFR measures, an LFR measure was administered to assess long-term knowledge about each lecture topic. Two days after viewing a videotape, students completed an LFR measure. As for the IFR measure, students were instructed to use the blank paper provided to write down as many facts, vocabulary, and lecture ideas as they could within a 5-minute period.

Similar to the IFR measure, interrater reliability was also assessed for the LFR measure. After an independent rater scored all of the LFR measures, one third of the randomly selected LFR measures were scored by a second rater. Interrater reliability for LFR was calculated to be .98 for CLP, .98 for NCLP, .98 for TLP, and .99 for TW.

**Comprehension test.** Each student was administered a 15-point multiple-choice test that resulted in each student’s test score (TS). In order to avoid ceiling effects, the level of difficulty for the comprehension test was set high. The test was developed from the content of the lecture, “Sicam Metal Workers.” The accuracy of the test content was confirmed by the second rater when this rater located and found the content pertaining to all of the questions and correct answers (i.e., 100%) in the lecture notes from the testing videotape.

Immediately following each IFR measure, students were administered the comprehension test. Students were not permitted to study for the test, nor were they permitted to use notes or any other materials. Using an answer key, an independent rater scored each test, and one third were rescored by a second rater that revealed 100% interrater reliability.

**Strategic note-taking student questionnaire.** One final measure was administered to students in the experimental group. Although it is not a dependent variable used to discern differences between the experimental and control group, it will be discussed in this context. The questionnaire was comprised of six statements with a 4-point Likert-type scale rating from 1 ("strongly disagree") to 4 ("strongly agree"). Specific items explored whether strategic-noting was helpful at recording better notes, remembering lecture information, and improving students’ science grade. In addition, one statement explored whether students preferred strategic note-taking over conventional note-taking, and two open-ended
questions asked students to identify what they liked and disliked most about strategic note-taking.

**Independent Variable**

The independent variable was strategic note-taking. (An abbreviated version of the strategic note-taking form is presented in Figure 1.) There were two levels of the independent variable. The first level included students who received the strategic note-taking training, whereas the second included students in the control group. Students in the control group were provided with lined paper and told to record notes as they typically would in class.

**Strategic note-taking strategy (SN strategy).** The SN strategy was developed to assist students as they listen to lectures by incorporating steps that help them focus attention on teacher cues and vocabulary in the lecture, as well as steps to help them organize lecture content such as clustering similar lecture ideas and summarizing (i.e., categorizing) clustered lecture points. In the strategy, each step prompts the student to perform an action using lecture information and the SN paper.

In the first step, the *Cluster* step, students are to cluster lecture information into manageable units of three to six related ideas and record the chunked ideas on the SN paper. The *Use* step prompts students to pay attention and listen for teacher cues (i.e., number cues and importance cues) during the lecture and, when they hear these cues, record the lecture points that are associated with them. During training, students were taught to recognize these two types of cues by identifying them in the videotaped training lecture (i.e., a student who recognized a lecture cue not only identified the content of the lecture point, but also stated whether it was a number or an importance cue). In the next step, *Enter*, students are to listen for vocabulary words and to list any vocabulary words from the lecture in the appropriate area on the SN paper. In the *Summarize* step, students are to write a word or words that would categorize the three to six lecture points they have already listed (i.e., clustered together) on the SN paper.

**Strategic note-taking paper (SN paper).** The SN paper was developed based upon Mayer’s SOI Model of Learning (1996). According to the SOI (i.e., selection, organization, and integration) model (Mayer, 2008), learning occurs through the three processes of (a) selection — students attend to incoming materials to determine what is relevant and what is not; (b) organization — students organize relevant incoming material into a coherent mental representation or build connections between the selected pieces of information; and (c) integration — students relate relevant incoming materials with existing knowledge from long-term memory.

Specifically, the first portion of the SN paper requested students to quickly identify the lecture topic and relate it to their knowledge of it. In doing so, students are able to draw connections between new and previously learned information, making the new information more “meaningful” and aiding memory of it (Peper & Mayer, 1986). The next part of the SN paper requested that students cluster together three to six main points with details from the lecture as they are being discussed. By summarizing (or categorizing) in the next step, it is believed that this step would aid students in encoding and storing information in long-term memory (Kiewra et al., 1991). If there were any new vocabulary or terms, students were to list them in the next part of the SN paper. The steps of naming three to six main points, summarizing immediately after naming lecture points, and listing new vocabulary or terms, were repeated until the lecture ended. The last page, which involved writing five main points and describing each, was intended to help students identify five important points from the lecture.

**Overall Procedures**

The study was conducted over four sessions. During the first two sessions, experimental group students were trained using the first videotaped lecture. In the third session, experimental and control students together viewed the second videotaped lecture, recorded notes, and completed the IFR and comprehension measures. The control group was provided with lined (blank) paper and instructed to use their conventional note-taking procedures to record notes from the videotape. The experimental group was provided with the SN paper and instructed to record notes as they had been trained during the previous two sessions.

After the videotape concluded and students finished recording notes, all notes were collected and the IFR was administered. Immediately upon completion of the 5-minute IFR, students’ IFR measures were collected, and the test was administered. In the fourth session (two days later), experimental and control students together completed the LFR measure. In addition, students in the experimental group were asked to complete the SN student questionnaire.

**Strategic Note-Taking Training**

During the first 50-minute training session, the primary investigator followed a scripted lesson and trained students on how to use the SN strategy for the SN form. Throughout the training, the investigator provided a brief description of strategic note-taking, modeled the technique, and guided students through practice portions of the videotaped lecture while providing appropriate feedback.
At the start of the initial training session, the investigator explained to students that strategic note-taking was a strategy that they would use in conjunction with the SN paper to help them record better notes. The investigator asked students to describe the kinds of problems they encountered when recording notes during class lectures. Student responses included problems with (a) writing and listening to the teacher at the same time, (b) trying to determine which lecture points were important to write down, (c) writing fast enough to keep up with the lecture, and (d) paying attention in a long class.

Next, the investigator told students he had a new way to take notes and that students who used this technique had improved the quality and quantity of their notes. Students were then given a page with the SN strategy steps listed (see Figure 2). The investigator asked them to look at and read along as he reviewed the strategy steps. Initially, the investigator spent a few minutes reviewing what is meant by the word cues. Students gave responses that related to a musical cue used in band and music classes, and they also spoke about a cue ball in billiards. The investigator used this information to relate it to teacher cues that are used in lectures, telling students that just as a musical cue tells the band when to begin playing, teacher cues tell students that something important is coming up; in this case, important lecture information.

The investigator then reviewed all of the letters (CUES) to show students that each letter prompts them to take some action when recording notes. In the Cluster step, students were told to listen for and record three to six related lecture points. Next, students were told that there are two kinds of cues that teachers use: number cues and importance cues. Students were given some examples (e.g., “there are three kinds of toads…”) of a number cue and asked what they need to do when they hear a number cue. Students responded that they have to write the information in their notes and include the number of lecture points that match the number cue (i.e., three). Students were then told that teachers use importance cues when they are about to say something important and that they should always record the important information in their notes. Again, the investigator gave examples (e.g., “this is important to know…”) and asked students to tell him importance cues that teachers in their classes use with them.

Next, the investigator discussed the Enter step and told students to enter on the SN paper any important vocabulary words that they hear during the lecture. Finally, the investigator discussed how students should quickly summarize three to six lecture points in the appropriate section of their notes.

The investigator then handed out the SN paper and reviewed it with students. During this portion of the training, the investigator pointed out to students how, once they begin using strategic note-taking with lectures, they should immediately complete the top portion of the page that asks them to describe what they know about the lecture topic. From there, the investigator reviewed the other section of the SN paper and described how it related to the SN strategy. In particular, he explained that naming and recording three to six main lecture points relates to the Cluster step of the strategy and that these three to six points could include cued lecture points (from the Use step) or other lecture points (i.e., noncued lecture points).

In the next portion of the SN paper, the investigator showed students where to Enter vocabulary words or terms and where on the paper students should quickly Summarize or categorize the lecture points in that portion of their notes.

At this point, students were verbally quizzed for 10 minutes on the steps of the SN strategy and asked what action to take in each step. Students were informed that after the day's session, they would be taking the strategy sheet home to study it. Next, the investigator told students that he would show them how to use strategic note-taking to record notes from a videotaped lecture (i.e., Frogs and Toads). The investigator turned on the videotape and began modeling the use of strategic note-taking (i.e., both the strategy and the paper) by writing notes on the SN paper and by using a “think aloud” technique to verbally convey his thoughts to students. For example, when a cued lecture point was given in the videotaped lecture, the investigator paused and remarked that it was a cue to write down important information. After about 5 minutes and at the end of the first portion of the lecture, the investigator stopped the tape and explained to students what he had written on the SN paper. He pointed out how he recorded words and phrases and how he did not record the lecture verbatim. He described how he clustered three to six ideas, listened for lecture cues, wrote down important vocabulary, and summarized clustered lecture points. He also noted that he was not concerned about spelling or grammatical errors, as long as the notes were written legibly.

After they had had an opportunity to ask questions, students were instructed to fill in the form as the next section of the videotaped lecture was played. Once students completed this next section, the videotape was stopped, questions were solicited, and student responses from their written notes were discussed. During each discussion, each strategy step was mentioned, as were the different types of lecture cues (i.e., number cues or importance cues) used in the videotape. This procedure was repeated until the end of the videotaped lecture.
During the second 50-minute training session, experimental students used the same videotape, but a new SN paper. The difference between this session and the previous training session was that the videotape was not stopped until the end of the lecture. Prior to this session, the investigator spent 10 minutes reviewing the SN strategy and SN form. This included asking students to recall from memory what to do in each strategy step. The investigator went around the room and asked each student to recall from memory the different strategy steps until all students could tell what to do in each step. Next, the investigator told students to get ready to take notes by completing the top section of the SN paper that asked students to write down what they knew about the videotaped lecture topic Frogs and Toads.

After students completed this portion of the SN paper, the videotape was started. As it was playing, the investigator walked around the room and encouraged slower students to continue recording notes. The purpose of this training session was to acclimate students with the speed of the lecture and improve their fluency at using strategic note-taking. At the end of the lecture, the investigator reviewed students’ notes with them for accuracy and completeness and verbally reinforced correct responses pertaining to the lecture points they recorded.

RESULTS

Data Analysis

Because more than one dependent variable was used in conjunction with the independent variable, a multivariate analysis of variance (MANOVA) was the preferred data analysis technique (Stevens, 2002) to answer the research questions. SPSS for Windows was used for the analyses, and the criterion alpha level used for statistical significance was .05. For the MANOVA, the effect size is reported as partial eta squared ($\eta^2_p$) and is used as an estimate of variance in the dependent variables (Tabachnick & Fidell, 2001). The effect size may be interpreted according to the following guidelines provided by Cohen (1988): $\eta^2_p = .010$ is small, $\eta^2_p = .059$ is medium, and $\eta^2_p = .138$ is large.

The first research question sought to answer the question whether students who used strategic note-taking would record more notes overall. The multivariate effect for strategic note-taking versus conventional note-taking on TLP and TW in students’ notes was significant, with Wilks’ $\Lambda = .58$, $F = 13.33$ (2, 37), $p < .01$, $\eta^2_p = .42$. Subsequent univariate tests indicated that strategic note-taking had a significant effect on both TLP, $F = 10.31$ (1, 38), $p < .01$, $\eta^2_p = .22$, and TW, $F = 24.22$ (1, 38), $p < .01$, $\eta^2_p = .39$. Students in the experimental group (see Table 2) who used strategic note-taking

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Number of Lecture Points and Words in Notes and Recall Measures</th>
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<tbody>
<tr>
<td>Dependent Variables</td>
<td>Experimental Students ($N = 20$)</td>
</tr>
<tr>
<td></td>
<td>$M$</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>TLP</td>
<td>16.50</td>
</tr>
<tr>
<td>TW</td>
<td>108.60</td>
</tr>
<tr>
<td>IFR</td>
<td></td>
</tr>
<tr>
<td>TLP</td>
<td>6.35</td>
</tr>
<tr>
<td>TW</td>
<td>40.00</td>
</tr>
<tr>
<td>LFR</td>
<td></td>
</tr>
<tr>
<td>TLP</td>
<td>4.45</td>
</tr>
<tr>
<td>TW</td>
<td>28.40</td>
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</table>
recorded more TLP in their notes (16.50) than students in the control group who did conventional note-taking (8.75). In addition, experimental students recorded more TW in their notes (108.60) than did control students (40.95).

The second question sought to answer whether students who used strategic note-taking would perform better than the control group on recall measures and the test. The multivariate effect for strategic note-taking versus conventional note-taking on TLP on IFR and LFR; TW on IFR, and LFR; and TS was significant, with Wilks' Λ = .63, F = 3.94 (5, 34), p < .05, ηp² = .37. Subsequent univariate tests indicated that strategic note-taking had a significant effect on TLP for the IFR, F = 7.84 (1, 38), p < .05, ηp² = .17; TLP for the LFR, F = 7.24 (1, 38), p < .05, ηp² = .16; TW for the IFR, F = 14.55 (1, 38), p < .05, ηp² = .28; TW for the LFR, F = 15.98 (1, 38), p < .05, ηp² = .30; and TS, F = 4.85 (1, 38), p < .05, ηp² = .32.

In terms of achievement, students in the strategic note-taking group wrote more lecture points (see Table 2) on both the IFR and LFR (6.35 and 4.45, respectively) than students who used conventional note-taking (3.85 and 2.45, respectively). They also wrote more words on both the IFR and LFR (40.00 and 28.40, respectively) than the control group (17.60 and 8.75, respectively); and they scored slightly higher on the test (9.90) than the control group (8.45).

The third and fourth questions sought to answer whether students who used strategic note-taking would record more CLP in notes and, subsequently, recall more CLP than the control group on recall measures. The multivariate effect for strategic note-taking versus conventional note-taking for CLP in notes and CLP on IFR and LFR was significant, with Wilks' Λ = .74, F = 4.25 (3, 36), p < .05, ηp² = .26. Subsequent univariate tests indicated that strategic note-taking had significant effects on CLP for notes, F = 10.61 (1, 38), p < .05, ηp² = .22; CLP for IFR, F = 7.66 (1, 38), p < .05, ηp² = .17; and CLP for LFR, F = 8.01 (1, 38), p < .05, ηp² = .17.

In terms of CLP (see Table 3), students with LD in the strategic note-taking group wrote more CLP in notes (i.e., experimental group mean of 7.95 versus control group of 4.55). Moreover, more of these CLP showed up in both IFR and LFR measures (3.10 and 2.10, respectively) when compared to students with LD who used conventional note-taking (1.65 and .95, respectively).

In terms of percentage of notes, students who used strategic note-taking recorded 47% of the total possible CLP from the lecture compared to 27% for students who used conventional note-taking. It appears that this larger percentage of recorded CLP aided students when they recalled LPs on short-term and long-term measures.

Finally, the results from the Strategic Note-taking Student Questionnaire indicated that students' ratings were in the upper range for all of the items (range for all items = 3.13 to 3.56). Items receiving the highest ratings were as follows: (a) strategic note-taking can help me improve my science grade, (b) strategic note-taking helps me to record better notes, and (c) I liked strategic note-taking better than my previous note-taking. Students' written comments about what they liked about strategic note-taking included the following: The SN strategy helped them record more organized notes

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**Table 3**

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Experimental Students (N = 20)</th>
<th>Control Students (N = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes CLP</td>
<td>M 7.95 (SD 4.32)</td>
<td>M 4.55 (SD 1.76)</td>
</tr>
<tr>
<td>IFR CLP</td>
<td>M 3.10 (SD 2.00)</td>
<td>M 1.65 (SD 1.23)</td>
</tr>
<tr>
<td>LFR CLP</td>
<td>M 2.10 (SD 1.48)</td>
<td>M .95 (SD 1.05)</td>
</tr>
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</table>
and helped them remember information better. Students’ dislikes included the following: The lecture was long, students had to write quickly, it took more time to write the information in the correct part of the SN paper, and summarizing made them miss certain lecture points.

DISCUSSION

As shown above, students who used strategic note-taking recorded more notes and performed better on recall and comprehension measures. These findings illustrate several important points of this study.

First, as illustrated in Table 2, students in the SN group recorded more lecture points; on average, almost twice as many as students who used conventional note-taking. Second, students in the SN group also recorded more words in their notes; on average, more than twice as many as students in the control group. These findings support and extend previous research that taught high-school students with disabilities to use SN to record lecture notes (Boyle & Weishaar, 2001). Further, in terms of percentage of overall notes recorded, when compared to the lecturer’s script, which contained 60 TLP, students in the SN group recorded 27.5% of the total possible LP, compared to students in the control group, who only recorded 14.6% of overall LP. While the middle-school students with LD in the current study were not as prolific as older students (i.e., studies that examined notes of college students) with NLD, the total percentage of lecture points recorded by middle-school students with LD (i.e., who used SN) in this study matched previous research conducted among middle-school students with NLD. For example, Kiewra and others have reported that college students with NLD recorded, on average, 35% of the total lecture points (Kiewra, DuBois, Christensen, Kim, & Lindberg, 1989), 32% (Kiewra et al., 1991), and 25% (O’Donnell & Dansereau, 1993). More important, among middle-school students with NLD, studies report that they typically record only 27% of lecture ideas (Risch & Kiewra, 1990).

Third, students who used SN performed better than students in the control group on three measures of achievement: IFR, LFR, and TS. In terms of the recall measures, on both IFR and LFR, students who used strategic note-taking recalled, on average, more lecture points regardless of the immediacy or duration of the recall measure. On these recall measures, again students in the SN recalled, on average, more than twice as many words as students in the control group, resulting in more detailed responses. Similarly, although differences in scores were not as profound, students who used SN performed better than students in the control group on the 15-point multiple-choice test. Again, the results support similar studies, which found that middle-school students (i.e., with NLD) who recorded notes outperformed students who did not record notes on measures of achievement (Laidlaw et al., 1993; Risch & Kiewra, 1990), while also extending them by examining the effects among students with LD.

Fourth, of importance was whether students who used SN would record more CLP. As shown, students in the SN group recorded more CLP and also recalled more CLP on recall measures (i.e., IFR and LFR). This represents an important finding because CLP have been shown to boost both note-taking and achievement (Titsworth, 2001a, 2001b; Titsworth & Kiewra, 2004). Not only does an instructor’s lecture cues help students discern important from less important lecture content (Titsworth, 2004), CLP also represent key lecture points that most teachers expect to see in their students’ notes. Moreover, given that teachers use CLP to signal important lecture content (Maddox & Hoole, 1975; Scerbo et al., 1997) and use the contents of lectures for developing tests and quizzes (Putnam et al., 1993), it would seem likely that CLP often form the basis of many test questions. Hence, while it is important for students to record notes in class, it seems especially crucial to record CLP. Again, the findings from the current study extend the research base (Titsworth, 2004; Titsworth & Kiewra, 2004), especially in terms of examining CLP recorded by middle-school students with disabilities in their notes and the resulting increases in achievement when compared to conventional note-takers.

Students who were taught SN performed better than students in the control group on measures of achievement. Other studies typically allow students to study their notes before taking a test to enhance long-term memory of lecture notes and to erase from working memory the recently presented lecture content (Lazarus, 1991; Titsworth, 2001a, 2001b, 2004; Titsworth & Kiewra, 2004). Without the aid of studying, students in the SN group in the current study still scored an average of 66% (i.e., 9.9 out of 15). Moreover, besides serving as a learning aid, notes serve as a permanent record of the lecture from which students can study from to prepare for tests. In other words, students with complete or detailed notes have an advantage over students who either have partial or fewer notes.

In terms of note-taking and current theory on working memory (Baddeley, 2003; Baddeley & Hitch, 1974; Baddeley, Hitch, & Allen, 2009), note-taking represents a complex and cognitively demanding task (Kobayashi, 2005; Peverly, 2006; Peverly et al., 2007). Specifically, note-taking involves listening to the lecture and holding the information in working memory (WM) while deciding which lecture points are worth recording, selecting or creating lecture points to record from WM,
and writing them quickly while simultaneously listening to new lecture content (Peverly, 2006). If all of this does not occur rather quickly and efficiently, information in WM will be lost.

In summary, to juggle all this, students must not only have good listening skills, but must be able to use selective attention to choose important points from the lecture, write the information in notes so that it is understandable (i.e., useful to the note-taker), and write quickly enough to be able to keep up with the lecturer.

The most successful note-takers are fluent writers, allowing more capacity in WM for higher-level processing of lecture information (Peverly, 2006), who have sufficient cognitive resources and abilities (i.e., strategies for listening, dictation, and writing) to process incoming lecture information (Altemeier, Jones, Abbott, & Berninger, 2006). Moreover, effective note-takers can easily switch attention back and forth from listening to the speaker to writing down notes, they can inhibit irrelevant lecture information (i.e., decide which lecture points are relevant to record and which are irrelevant), and they can effectively access long-term memory (LTM) to move ideas from LTM to WM as they relate to incoming lecture points (Altemeier et al., 2006; Berninger, Nielsen, Abbott, Wijsman, & Raskind, 2008; Berninger, Raskind, Richards, Abbott, & Stock, 2008; Swanson, Zheng, & Jerman, 2009).

Unfortunately, for students with LD, many components of the note-taking process present difficulties. In many cases, excessive WM load has been implicated as the main cause of students’ inability to effectively record notes from lectures (Gathercole, Lamont, & Alloway, 2006; Peverly, 2006). Reducing the load on working memory through the use of supports, such as strategic note-taking and guided notes, can aid student learning (Gathercole et al., 2007). Other supports, such as employing teacher cues (verbal or written) or injecting pauses in the lecture also help reduce the load on WM. The use of these types of supports reduces load on WM, particularly verbal WM, and help to increase attention toward the important aspects of the lecture (Altemeier et al., 2006; Berninger et al., 2008).

When interpreting the results of the current study, the following limitations should be kept in mind. First, the study used only one videotaped lecture to determine the effectiveness of SN on student note-taking and learning compared to students who used conventional note-taking. Future studies should examine multiple lectures on several different science topics to determine if SN can generalize to other lectures.

Second, the study used a videotaped lecture as opposed to live lectures. While the videotaped lecture allowed controlling extraneous variables, it was still presented as a contrived lecture that did not allow for interactions as typically occur in middle-school science classrooms. Furthermore, since teachers present lectures in different delivery formats, it is possible that the videotaped lecture was less “teacher-friendly” than most lectures presented in middle-school science classrooms.

Third, students were informed that neither their notes nor the test would be used toward their grades. It is possible that students were not motivated to record “generative” notes that would have aided their performance when recording notes and on subsequent tests (Slotte & Lonka, 2001).

Future research should explore other aspects of note-taking for middle-school students with LD. First, research is needed that examines the effects of note-taking on delayed recall tests and other comprehension tests. Since typical classrooms tests occur several days or weeks after the lecture, future research should examine student performance on delayed tests to see what effects a note-taking technique over a longer period of time would have on performance. Second, future research should examine how adding a review session after note-taking could aid student learning. Using review periods of various lengths (e.g., 5 minutes vs. 15 minutes) might show whether reviewing notes for a certain length of time maximizes test performance, as well as long-term recall. Finally, future research should examine the effects of various types of lecture cues (i.e., written versus verbal) to determine which type is the most effective for the note-taking of students with LD.

Implications for Practice

When teaching students note-taking skills and strategies, teachers should take into account several variables during training. First, teachers should use well-known lecture content so that students can focus on accurately using the skills and strategies. Teachers should then monitor students’ use of the different strategy steps to ensure proper use and provide feedback to students throughout the various parts of the training. Second, since cued lecture points are important for students to record in their notes, teachers should be familiar with the different types of lecture cues used in students’ classes. These types should be taught to students so that they can begin to recognize these cues and use them as they record notes. Third, since students with disabilities might have difficulty keeping up with the lecture, teachers should teach them how to abbreviate words (e.g., write only the first four letters of a long word), as well as common abbreviations (e.g., & for and, / for with, bc for because), as one way to help students save time when writing. Finally, once students become comfortable recording “practice” lecture notes, teachers should consider presenting practice lecture content at a faster pace to replicate authentic classroom lectures.
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