HANDBOOK OF COLLEGE READING AND STUDY STRATEGY RESEARCH

SECOND EDITION

EDITED BY
RONA F. FLIPPO • DAVID C. CAVERLY

10 Notetaking From Lectures

Bonnie B. Armbruster
University of Illinois at Urbana–Champaign

Lecturing is a predominant form of instruction in U.S. classrooms from middle school through college. A sample of 120 7th- and 10th-grade teachers reported spending about 50% of their class periods lecturing, with slight increases in the amount of time spent lecturing from 7th to 10th grade (Putnam, Deshler, & Schumaker, 1993). In college, lecturing is an even more pervasive instructional method. Anderson and Armbruster (1986) claimed that college students typically spend at least 10 hours per week attending lectures. Given that a normal course load for undergraduates is 15 credit hours, 10 hours per week amounts to approximately 80% of class time spent listening to lectures. Lecturing may have "recently come into disrepute as a method of teaching" (deWinstanley & Bjork, 2002, p. 19) because of a current emphasis on active learning and cooperative learning. Nonetheless, lecturing remains a common and often indispensable instructional method for college students. According to a 2001 report from the National Center for Education Statistics,

> Lecturing remains the primary instructional method in postsecondary education. In fall 1998, 83% of faculty and staff with instructional responsibilities at the undergraduate, graduate, or professional level reported using this format as their primary instructional method in at least one class taught for credit. (Wirt et al., 2001, p. 77)

Therefore, little has changed since Carrier, Williams, and Dalgaard (1988) observed, "The lecture method remains a 'sacred cow' among most college and university instructors" (p. 223).

Titsworth (2004) quipped, "If lecturing is a teacher's sacred cow, then notetaking is a student's Holy Grail" (p. 306). College students widely embrace taking notes as a useful strategy for learning lecture content. For example, in a survey of U.S. and international university students (Dunkel & Davy, 1989), 94% of U.S. students and 92% of international students reported that notetaking is a valued and important activity. As Carrier (1983) explained,

> perhaps no study strategy would be more staunchly defended by students and teachers alike than that of recording notes while listening to lectures. Asking students to surrender their notebooks and pens at the beginning of a lecture is likely to incite a minor uprising. Instructors too would be uncomfortable. Most have grown accustomed to viewing a roomful of students busily recording information as a sign that students are actively engaged in learning from the lecture. (p. 19)

Notetaking has
learning, Robert C
as anyone knows,
Gagne's opinio
value and practice
(Titsworth, 2001).
the strongest pred
college human dev
As important a
demanding cognit
the lecture, select
ory, interpret the
constraints are a p
cal speaking speed
only about 0.2 to (
processes are invo
huge demands on t
of working memor
freshmen face is d
large-lecture intro
remains a challeng
What is known
typical practices ar
and students impr
questions by revie
notetaking from le
ing the value of tak
ing on research con
for practice and fu
Most of the rese
of the 1980s and
Relatively fewer st
reflecting the view
2002) and thus les
is little published r
notetaking from le

OVERVIEW OF T

The current cogniti
the importance of c
tion, encoding, lea
generative (e.g., Wi
of information. Ra
relationships amon
knowledge, beliefs,
to-be-learned infor
tions, while the bui
tion, including exist

Notetaking has not always been valued, however. In his 1965 book, *The conditions of learning*, Robert Gagne asserted that "Most (students) may be taking notes which, so far as anyone knows, is an entirely useless activity quite unrelated to learning" (p. 287).

Gagne's opinion notwithstanding, it is fortunate that most college students today value and practice notetaking, for "notetaking is a crucial aspect of academic success" (Titsworth, 2001). For example, Williams and Worth (2002) found that notetaking was the strongest predictor (among several variables) of students' overall performance in a college human development class.

As important as it is, taking notes from lectures is a particularly complex and demanding cognitive activity (Piolat, Olive, & Kellogg, 2005). Students must listen to the lecture, select important ideas, hold and manipulate these ideas in working memory, interpret the information, decide what to record, and then write it down. Time constraints are a particular problem for students taking notes from lectures, as typical speaking speed is about 2 to 3 words per second, while typical writing speed is only about 0.2 to 0.3 words per second (Piolat et al., 2005). Because multiple cognitive processes are involved under tight time constraints, taking notes from lectures makes huge demands on the limited resources of the central executive and storage components of working memory. Indeed, "one of the major cognitive challenges that most college freshmen face is developing the listening and notetaking skills they need to survive in large-lecture introductory courses" (Ryan, 2001, p. 289). And, of course, notetaking remains a challenge beyond the freshman year.

What is known about the effect of taking lecture notes on learning? What are some typical practices and individual differences in student notetaking? How can instructors and students improve learning from lectures? This chapter attempts to answer these questions by reviewing some of the rather large body of research on college students' notetaking from lectures. The chapter begins with a brief overview of the theory regarding the value of taking notes from lectures, followed by a review of the research, focusing on research conducted within the past 25 years. A conclusion, including implications for practice and further research, rounds out the chapter.

Most of the research on notetaking from lectures was published during the decades of the 1980s and 1990s, most notably the work by Kenneth Kiewra and colleagues. Relatively fewer studies have been conducted thus far in the new millennium, perhaps reflecting the view that lecturing has become less reputable (deWinstanley & Bjork, 2002) and thus less worthy of study. One unfortunate result, however, is that there is little published research on the effect of newer classroom technologies on student notetaking from lectures.

OVERVIEW OF THE THEORY

The current cognitive-constructivist view of learning (e.g., Phillips, 2000) focuses on the importance of cognitive processes such as motivation, attention, knowledge acquisition, encoding, learning strategies, and metacognition. According to constructivist or generative (e.g., Wittrock, 1990) views of learning, learners are not passive recipients of information. Rather, learners actively construct, or generate, meaning by building relationships among the parts of the to-be-learned information and their own existing knowledge, beliefs, and experiences. The building of relationships among parts of the to-be-learned information is referred to by Mayer (1984) as building *internal connections*, while the building of relationships among new information and other information, including existing knowledge, is called *external connections*.

Theoretically, the greatest learning occurs when learners engage in the most generative activities. With regard to learning from lectures, the greater quantity and quality of connections the student can make among bits of information in a lecture (internal connections) and between lecture information and prior knowledge (external connections), the greater the learning that should occur. For students taking notes from lectures, generative processing can occur at two stages—as they take the notes while listening to the lecture and as they review the notes prior to a course examination. As already discussed, generative processing while taking notes is especially difficult because the task is so cognitively demanding. Generative processing during review, however, should be easier because students do not have to engage in so many cognitive processes simultaneously.

We turn now to a review of research on notetaking from lectures, primarily from the last 25 years. The review begins with research on the functions that notetaking serves in learning. Next, studies of "typical" notetaking—the type of notes students take when they are left to their own devices and how these notes affect learning—are discussed. Then, research on individual differences in learning and notetaking are reviewed. Finally, the review turns to research on efforts to improve notetaking and reviewing notes. Because most of the studies reviewed were conducted over the past 25 years, they were primarily cast within the predominant theoretical framework of cognitive-constructivism and generative learning.

REVIEW OF THE RESEARCH

The functions of notetaking in learning from lectures

A study of notetaking from lectures conducted early in the cognitive-constructivist research tradition was a seminal study by DiVesta and Gray (1972), which established two functions of taking notes from lectures: *encoding* and *external storage* (also known as the *process* and *product* functions of notetaking). The encoding, or process, function suggests that taking notes facilitates learning by affecting the nature of cognitive processing at the time the lecture is delivered and the notes taken. In other words, notetaking may be a generative activity because it encourages learners to build connections among lecture information and between lecture information and prior knowledge and experience. The external storage function suggests that notes are valuable as a product because they are a repository of information for later review and additional cognitive processing. The learner can review lecture notes to prevent forgetting, to relearn forgotten information, or as the basis for further generative activities.

The encoding and external storage functions of notetaking have been investigated in scores of studies since DiVesta and Gray's (1972). In these studies, the encoding function was measured by comparing the performance of students who listened to a lecture and took notes with the performance of those who listened to a lecture without taking notes, with neither group allowed to review prior to the criterion test. The external storage function was tested by comparing the performance of students who reviewed their notes with the performance of those who did not review their notes prior to the criterion test.

These earlier studies of the encoding and external storage functions have been reviewed extensively by Hartley (1983) and Kiewra (1985a, 1989). In general, the external storage function of notetaking has found support in the research literature, whereas findings regarding the encoding function are mixed. For studies comparing the two functions, the external storage function has proven more beneficial. In summary, as Hartley and Kiewra concluded in their reviews, both the encoding (process) and external storage (product) functions of notetaking contribute to learning from lectures; however, the external storage function appears to be more important.

From his reviews of many studies comparing the encoding and external storage functions, Kiewra and colleagues (e.g., Kiewra, DuBois, Christensen, Kim, & Lindberg, 1989; Kiewra, DuBois, Christian, McShane, Meyerhoffer, & Roskelley, 1991) noted a methodological problem with the encoding versus external storage research paradigm. The traditional studies confounded the two functions because the subjects in external storage conditions had both recorded and reviewed their own notes and had thus been involved in both encoding and external storage. Therefore, Kiewra et al. (1989) and Kiewra et al. (1991) proposed renaming the traditional storage function as an *encoding plus storage* function. They also proposed a new, independent storage function, involving review of notes from a lecture the learner had not attended and therefore had not had the opportunity to encode. These variations produced three notetaking functions: (a) the original *encoding* function (take notes/no review), (b) the renamed *encoding plus storage* function (take notes/review), and (c) the new *external storage* function (review provided notes).

Kiewra and colleagues investigated these three newly defined functions of notetaking in two studies reported here. Kiewra et al. (1989) investigated the three functions of notetaking in conjunction with three notetaking techniques. Noting that in the traditional encoding versus external storage research, those in the external storage group had two opportunities to process the material (one while taking notes and one while reviewing) while the encoding group had only one opportunity for processing (while taking notes), Kiewra et al. equalized the processing opportunities among function groups in this study. Therefore, the function groups were redefined: (a) encoding (takes notes on two occasions without review), (b) encoding plus storage (takes notes one time and reviews notes the next), and (c) external storage (reviews a set of borrowed notes on two occasions). (In addition to being assigned to one of the notetaking functions, students in the study were assigned to one of three notetaking techniques—conventional, skeletal, and matrix. These techniques, however, are not relevant to the present discussion; they are discussed later.)

In the first session of the study, students viewed a 19-minute videotaped lecture according to directions appropriate to their assigned function and technique. One week later, they finished the second phase of the experiment and then completed four tests: (a) free recall, (b) factual recognition, (c) synthesis (forming a relationship that had not been explicitly stated in the lecture), and (d) application (classifying new examples according to lecture concepts).

Results relevant to this discussion include the following: On the recall test, there was a main effect for notetaking function, with the encoding plus storage group outperforming both the encoding and external storage groups. The recognition test produced a marginally significant main effect for function, with follow-up tests indicating a significant advantage for the encoding plus storage group over the encoding group. There were no significant effects for the synthesis and application tests. Therefore, the opportunity to review notes appears to facilitate performance on lower-level types of learning (recognition and recall), but not on higher levels of learning (synthesis and application).

In the Kiewra et al. (1991) study, the three notetaking functions and three notetaking techniques were again investigated. This time, however, processing opportunities for the function groups were not equalized. The function groups were defined as: (a) encoding (take notes/no review), (b) encoding plus storage (take notes/review notes), and (c) external storage (no lecture/review borrowed notes). University students viewed the same 19-minute videotaped lecture and then completed tests of cued recall and synthesis (requiring forming relationships not explicitly stated in the lecture).

Results relevant to this discussion included the following: (a) the encoding plus storage group outperformed the encoding group on both tests; (b) the encoding plus storage group outperformed the external storage group on the cued recall test; (c) on the

synthesis test, the external storage group scored higher than the encoding only group; (d) there were no performance differences between students who took notes but did not review them and control students who neither took nor reviewed notes; and (e) there were no differences on either measure between the encoding group and a control group that simply viewed the lecture without taking notes or reviewing.

The results for notetaking function are consistent with results of earlier studies examining simply the encoding versus old, external storage functions: Students who review notes achieve more than students who do not review notes. The findings—that the external storage function results in higher synthesis performance than the encoding function and that there were no performance differences between students who took notes but did not review them and students who neither took nor reviewed notes—indicate that notetaking alone does not serve an encoding function.

In summary, two studies (Kiewra et al., 1989; Kiewra et al., 1991) using reconceptualized functions of notetaking have replicated and extended previous findings. The bottom line is that the real value of taking notes is to have them available for review prior to performing the criterion task. The probable reason for this finding was stated previously: Because taking notes is such a cognitively demanding task, there is limited opportunity for generative processing at the time of encoding. Reviewing notes, however, offers a second opportunity for generative processing, one that is not as cognitively demanding as notetaking itself.

Research on the functions of notetaking reviewed so far have explored effects of notetaking on more traditional measures of learning from lectures, that is, various forms of recall and comprehension tests over lecture content. One study identified for this review, however, investigated the functions of notetaking with respect to a different measure of learning. Benton, Kiewra, Whitfill, and Dennison (1993) conducted a series of four experiments in which they studied the effects of various notetaking conditions on college students' ability to write a compare-contrast essay, a measure of learning often found on essay examinations in higher education.

In the first two experiments, students either only listened to a 19-minute videotaped lecture or listened and took notes, using one of the three notetaking techniques used in previously reviewed studies by Kiewra et al. (1989, 1991): (a) conventional notes, (b) outline framework, or (c) matrix framework. In Experiment 1, subjects listened to the lecture and then immediately composed a compare-contrast essay about lecture content either with or without notes present. Experiment 2 replicated Experiment 1 except that students wrote the essay 1 week after the lecture. The essays were analyzed for length (number of words and number of text units), as well as for two measures of organization—cohesion and coherence.

In both experiments, students who wrote from their own notes (representing encoding plus external storage) composed longer and more organized essays than subjects writing without their notes (representing encoding only), thus lending further support to the encoding plus external storage function of notetaking for this measure of lecture learning. This encoding plus external storage effect was enhanced with the 1-week delay between lecture and writing. In other words, having one's own lecture notes available for reference enhances both the length and the organization of writing based on lecture content.

Because the first two experiments had not isolated the external storage effect of notetaking, Benton and colleagues (1993) conducted two more experiments. In Experiment 3, students viewed the same lecture as in the first two experiments without taking notes. Immediately after the lecture, they were asked to write the compare-contrast essay, given either no notes or notes presented in one of the three notetaking formats. Experiment 4 replicated Experiment 3 except that there was a 1-week delay between the lecture and the essay-writing. For the immediate writing task, no differences were found between the essays of those who had written with or without notes. For the delayed

writing task of Experiment 4, however, students using provided notes wrote longer essays than did students who did not use notes. Therefore, the value of the external storage function of notetaking was demonstrated on a delayed task, but not on an immediate one. Apparently, the provision of notes compensated for loss of lecture information during the delay.

Having examined the general functions of notetaking in learning from lectures, we turn now to typical notetaking and how typical notetaking affects learning.

Typical notetaking and learning from lectures

When left to their own devices, students, even college students, do not take very good notes. Students' notes tend to be quite incomplete records of lecture content. According to Kiewra et al. (1989), earlier studies found that students often record fewer than 40% of lecture ideas. Several studies by Kiewra et al. have replicated this finding. In one study by Kiewra (1985c), students recorded only about 20% of a lecture's critical ideas. Kiewra, Benton, and Lewis (1987) found that students recorded 37% of total lecture ideas. In another study (Kiewra, DuBois, Christian, & McShane, 1988), students recorded 31% of lecture ideas. O'Donnell and Dansereau (1993) reported that college students recorded only 25% of the total number of lecture idea units. Judging from these studies, then, college students probably only record somewhere between 20% and 40% of lecture information

The quantity of notes taken appears to vary over time as well. Scerbo, Warm, Dember, and Grasha (1992) found that students recorded increasingly less information in their notes over the course of a lecture. The fact that students record relatively few lecture ideas should not be surprising, given the cognitive complexity of the task. The decrease in quantity of notes over time probably reflects fatigue due to the demanding nature of the task of notetaking. With fatigue, one or more of the component cognitive processes may break down.

Researchers have investigated how the quantity of notes relates to learning. Kiewra (1985a) reviewed earlier research providing substantial evidence that students who take a greater quantity of notes tend to perform better on measures of learning from lectures. Subsequent studies have confirmed this finding. In a study by Kiewra and Fletcher (1984), the total number of words recorded in notes was significantly related to immediate and delayed test performance, particularly on items that asked students to summarize main ideas and relate main ideas to far transfer situations. Baker and Lombardi (1985) found significant positive correlations between the content of students' notes and performance on a multiple-choice test of lecture content administered 3 weeks after the lecture. The more information students included in their notes, the better they did on test items corresponding to that information. In a study by Kiewra, Benton, and Lewis (1987), although total number of words in notes was not related to learning on a lecture-specific test given 1 week after the lecture, note completeness was significantly related to performance on a subsequent course exam covering more than the specific lecture information. Kiewra and Benton (1988) found that the numbers of words, complex propositions, and main ideas in students' notes correlated significantly with their performance on a lecture-specific test as well as on a subsequent course exam over unrelated material. In a study by O'Donnell and Dansereau (1993), the number of words in students' notes correlated positively with free recall of both important ideas and details from a lecture. A study by Cohn, Cohn, and Bradley (1995) found a positive relationship between notetaking completeness and learning as measured by an immediate multiple-choice test covering lecture content. Finally, in the research of Benton et al. (1993), length of lecture notes was significantly correlated with length and organization of compare-contrast essays students wrote about lecture content.

In summary, there is considerable evidence over several decades of research that note completeness is positively related to achievement. This result is consistent with research on the functions of notetaking. More complete notes may reflect greater generative processing during encoding. Alternatively, and probably more likely, the more complete students' notes, the more material students have available for review and the greater their opportunity for generative processing at the time of review.

In addition to examining the sheer quantity of notes, research has also investigated the quality of notes in terms of how well notes represent the main ideas of the lecture. Kiewra, Benton, and Lewis (1987) found that although student notes were incomplete, they did capture the most important points of the lecture. The relative importance of the lecture information noted by students is also related to learning. In two studies (Einstein, Morris, & Smith, 1985; Kiewra & Fletcher, 1984), students who took notes capturing the most important lecture ideas recalled the most lecture content. However, the aforementioned study by Kiewra et al. (1987) found that, because students generally recorded the most important lecture points in their notes, it was the intermediate level ideas that correlated significantly with performance on both immediate and delayed tests of lecture content. In other words, the completeness of notes at intermediate levels of importance was the characteristic that most distinguished lower from higher achievers. Furthermore, the completeness, or elaborateness, of notes becomes more important over time, as shown by higher correlations between middle-level notes and achievement on a delayed test than on an immediate test. Again, this result supports the relative importance of the review function of notetaking: The more complete or elaborate the notes available for later review, the greater the potential for generative processing during review.

In more recent research, Peverly and colleagues (2007) scored both the quantity and quality of notes taken on a 20-minute videotaped lecture by undergraduates in an introductory psychology course. In two studies, the researchers examined the relationship between notes and a criterion task consisting of writing an organized summary of the lecture without reference to their notes. Among other findings, Peverly et al. demonstrated that quality of notes was significantly and positively related to performance on the summary task. Commenting on the oft-demonstrated strong relationship between notes and test performance, the authors concluded that notetaking is a better predictor of test performance than many other logical predictors, such as verbal ability and GPA (but, according to some research, not necessarily a better predictor than background knowledge or metacognitive ability).

Individual differences in notetaking and learning from lectures

Although the previous section described research related to typical notetaking behaviors and their effect on learning, other research has shown that notetaking and learning from lectures are influenced by individual differences. Most of the individual differences investigated to date are differences in cognitive variables, including working memory, cognitive style, transcription fluency, conceptual models of lecture learning, prior knowledge, and overall cognitive ability. Gender differences have also been investigated to some extent. Each of these variables will be discussed below.

Working memory

As previously discussed, taking notes from lectures makes huge demands on the limited resources of the central executive and storage components of working memory. A few studies have examined the relationship between working memory and notetaking. Kiewra (1989) reviewed earlier studies showing that students with greater working memory

ability benefited from taking notes, while students with less memory ability did not benefit from notetaking. Presumably, for students with less working memory ability, notetaking actually interferes with their ability to encode information from the lecture. In a more recent study (Hadwin, Kirby, & Woodhouse, 1999), however, students with higher working memory capacity performed better on recall measures if they listened to a lecture without taking notes and then reviewed provided notes. The authors surmised that this unexpected result might be attributed to the difficulty of the lecture. Students who were able to listen without taking notes had fewer demands on their working memory.

Kiewra et al. (Kiewra & Benton, 1988; Kiewra, Benton, & Lewis, 1987) extended their earlier work by examining the relationship between working memory ability and notetaking behaviors. Furthermore, they measured working memory not as capacity only, but as a measure of ability to both hold and manipulate verbal information in working memory. Kiewra and colleagues found that the ability to manipulate information in working memory was directly related to notetaking behavior. Specifically, students who are less able to hold and manipulate information in working memory recorded fewer words and total ideas (Kiewra & Benton, 1988; Kiewra et al., 1987), as well as fewer subordinate ideas (Kiewra et al., 1987). Thus, the result using a more sensitive measure of working memory confirmed the results of other research in showing less effective notetaking among students with poorer working memories. Hadwin et al. (1999) also found a positive relationship between working memory capacity and quality of notes.

On the other hand, Cohn et al. (1995) failed to find a relationship between working memory and the number of words recorded in notes, although working memory did have an important effect on lecture-specific learning. The previously mentioned study by Peverly and colleagues (2007) investigated the relative contributions of three individual variables they hypothesized to influence notetaking quantity and quality, including working memory. The students were assessed on their working memory by means of a listening span test. Contradictory to the researchers' expectations, they did not find working memory capacity to be a statistically significant predictor of either the quality of notes or the ability to write an organized summary. Peverly et al. offered several explanations for this finding and recommended the use of additional working memory tasks in future studies.

Given the conflicting results of several research studies, the verdict is yet out on the relative contribution of working memory to notetaking. Obviously, working memory is a complex construct requiring considerably more research attention.

Cognitive style

Another cognitive variable related to notetaking is the cognitive style of field independence and field dependence. Field-independent learners have an active, flexible, hypothesis-testing approach to learning; they abstract and restructure incoming information. Field-dependent learners, on the other hand, have a more passive and rigid approach to learning; they tend to process the information in its given structure. Frank (1984) investigated the effect of field independence and field dependence and four different notetaking techniques (no notes, student's notes, outline framework of lecture content on which students were to take notes, and complete outline plus any additional notes the student wished to add) on immediate learning from a lecture as measured by comprehension-level items. Results included the finding that field-independent students outperformed field-dependent students in the students' notes condition; however, there were no differences in performance between the two types of learners for the other three notetaking techniques. Also, field-dependent students performed significantly worse

when they took their own notes than when they were provided with a complete outline on which to take notes.

Fran (1984) also analyzed the notes of field-dependent and field-independent students. Compared to the notes of field-dependent students, the notes of field-independent students were more efficient (calculated as the ratio of information units recorded to number of words recorded) and tended to be in an outline format. Apparently the more active learning style of field-independent students enabled them to benefit more from the encoding function of notetaking. The field-dependent students, on the other hand, had difficulty abstracting and organizing information from the lecture. External structural support in the form of a complete outline helped these learners, perhaps by aiding either their encoding or their review.

Kiewra and Frank (1988), pointing out that the previous Frank (1984) study failed to differentiate between the encoding and external storage effectiveness of instructional supports for field-dependent learners, undertook a study to correct this shortcoming. In the Kiewra and Frank study, field-dependent and field-independent students used one of three notetaking techniques (personal notes, skeletal notes consisting of headings and subheadings of critical lecture points, or detailed instructor's notes containing all critical lecture points organized into an outline form) to record notes from a 20-minute videotape. Following the lecture, students completed an immediate multiple-choice test consisting of 50% factual items and 50% higher-order knowledge items (application, analysis, synthesis, and problem-solving). Five days after the lecture, students had an opportunity to review their notes prior to completing the same test. Results included the finding that field-independent learners outperformed field-dependent learners on both factual and higher-order items. Furthermore, the cognitive style differences were more pronounced on the immediate factual test than on the delayed factual test, when time was allowed for review and additional encoding. The authors concluded that field-dependent learners benefit more from the external storage function of notetaking than from the initial encoding function.

Transcription fluency

Peverly and colleagues (2007) hypothesized that transcription fluency, or the rate of writing words, might predict notetaking quality and recall because previous research on writing had shown that transcription fluency was related to the quality of written compositions and because notetaking demands rapid writing. In the study described previously, Peverly et al. measured transcription fluency in two ways: in an alphabet task, in which students wrote as many letters as they could in a given time, and by a standardized writing fluency task. Among the results of the study was the finding that transcription fluency, measured by letter fluency, was a significant predictor of the quality of notes. The authors suggested that, because transcription fluency is related to a number of writing outcomes, early instruction in handwriting might improve lecture notetaking by secondary and college students.

Conceptual models of learning from lectures

Acknowledging that little is known about why students take the kinds of notes they do, Ryan (2001) conducted a study to identify different conceptual models of lecture learning and to determine whether particular notetaking practices are associated with the different models. Ryan developed six metaphors (models) reflecting how students think about learning from lectures: Listening to a lecture is like trying to be a *sponge, tape recorder, stenographer, code breaker, reporter,* or *explorer.* After listening to a 5-minute lecture, 84 college students rated their frequency of use of specific notetaking

practices, each of which was consistent with 1 of the 6 metaphors. Results indicated that for 5 of the 6 metaphors, student preference for the metaphor correlated positively with their reported use of notetaking practices associated with that metaphor.

Prior knowledge

Peper and Mayer (1986) examined the interaction of prior knowledge of lecture topic and notetaking behavior on near and far transfer tasks. Subjects with low prior knowledge who took notes performed better on far transfer tasks that those who did not take notes; non-notetakers with low prior knowledge, however, performed better on near transfer tasks. On the other hand, for subjects with higher prior knowledge of the lecture topic, notetakers did not outperform non-notetakers on the far transfer task. Peper and Mayer speculated that subjects with adequate background knowledge automatically generate external connections, or connections between lecture content and what they already know, whereas those without adequate background knowledge benefit from potentially generative activities, such as taking notes, to help them make connections between lecture content and prior knowledge.

Besides prior knowledge of lecture content, another form of prior knowledge is knowledge of the language spoken by the lecturer. Dunkel, Mishra, and Berliner (1989) examined the effect of language proficiency on learning from lectures. Native and non-native speakers of English either listened only or listened and took notes on a 22-minute videotaped lecture. Immediately following the lecture, the students completed a multiple-choice test over lecture concepts and details. The relevant result here is that native speakers recalled significantly more of the concept and detail information presented in the lecture than did the non-native speakers. However, there was no significant interaction between notetaking and language proficiency. The authors speculated that cognitive competition among the international students' first and second languages interferes with encoding of lectures delivered in the second language, a result which theoretically should be compounded by notetaking. Further research is obviously needed to shed light on the relationship between notetaking functions and language proficiency.

Cognitive ability

A final cognitive difference that has been studied to some extent is the difference between college students who have learning disabilities and those who do not. Hughes and Suritsky (1993) reported on an earlier study by Suritsky, in which she interviewed college students with learning disabilities about the difficulties they had with notetaking, the reasons for those difficulties, and the strategies they used to take notes. These students believed they had significant problems with taking notes during lectures and did not report using systematic and efficient strategies to help themselves. Hughes and Suritsky followed up on this study by comparing the lecture notes of 30 learning-disabled (LD) and 30 non-disabled (ND) college students. Significant differences were found on the number of information units recorded, with ND students recording an astounding 60% to 70% more lecture information than LD students. One factor accounting for the relatively low amount of lecture information recorded by LD students may be that they did not make nearly as much use of abbreviations in their notes as did ND students.

Gender

In addition to cognitive variables, another individual difference that has been studied is gender differences. Cohn et al. (1995) reported that, compared to males, females recorded more total words and more detailed information about lecture content. An

unpublished dissertation by Eggert (2000), described in Williams and Eggert (2002), also found that female college students recorded more complete and accurate notes than did males. Also, notetaking by females was more predictive of the major performance measures in the course than notetaking by males. Carrier, et al. (1988) used survey results to determine that females valued notetaking more than males, were more confident in their ability to take notes, and saw themselves as more active notetakers.

In summary, research has revealed several individual differences in notetaking and learning from lectures regarding the cognitive variables of (a) working memory, (b) cognitive style (field dependence and field independence), (c) transcription fluency, (d) prior knowledge of lecture content and language of lecture delivery, (e) conceptual models of learning from lectures, and (f) overall cognitive ability (learning disabled versus non- learning disabled). First, students with greater working memory are more effective notetakers than students with less working memory ability. Second, field-independent students benefit more from the encoding function of notetaking, while field-dependent students benefit more from the external storage function. Third, students who can write faster appear to record higher quality notes. Fourth, compared to subjects with higher prior knowledge of lecture content, subjects with lower prior knowledge perform better on far transfer tasks, perhaps because notetaking helps them make connections between lecture content and their limited prior knowledge. Fifth, hearing a lecture in one's non-native language may interfere with notetaking functions. Sixth, students' conceptual models of notetaking and learning from lectures probably influence their notetaking practices. Finally, college students who have learning disabilities record significantly fewer notes than students who do not have learning disabilities. In addition, research has revealed some differences between male and female notetakers, with females appearing to be better notetakers.

Having examined the questions of what type of notes students take when left to their own devices and how individual differences in cognition affect notetaking and performance, we turn to the challenge of how to improve learning from lectures.

IMPROVING LEARNING FROM LECTURES

Based on the functions that notetaking can serve, two possibilities for improving learning from lectures are to: (a) enhance the initial encoding of lecture material by improving the generative processing that students engage in while taking notes, and (b) enhance the external storage function of notes by increasing the potential for generative processing during note review. Research on improving both notetaking and review is discussed in this section.

Improving notetaking

Kiewra (1989) has suggested three ways in which the quality of student notes might be improved in order to facilitate learning from lectures, based on generative theories of learning: (a) improve the completeness of notes, (b) help students make relationships among lecture ideas, and (c) help students make relationships between lecture ideas and prior knowledge. Kiewra and his colleagues, as well as other researchers, have undertaken numerous studies to investigate techniques for improving notetaking. These techniques include giving simple verbal directions, providing lecture handouts of various kinds, and varying the lecture itself.

Giving verbal directions

In an early study in this program of research, Kiewra and Fletcher (1984) tried to manipulate notetaking by directing students to take notes in different ways. Students were told to take notes in one of four different ways: (a) writing their usual way, (b) emphasizing factual details, (c) focusing on conceptual main points, or (d) discerning relationships within the material. Student notes were analyzed for factual, conceptual, and relational information. Results revealed that the differential directions had little effect on notetaking behavior: Students took about the same number of conceptual notes covering the main points of the lecture regardless of directions. The differential directions also had no significant effect on performance on immediate or delayed retention tests. Correlational analyses, however, disclosed that students who noted more main ideas outperformed more factual notetakers on factual, conceptual, and relational test items. The authors concluded that because simple verbal directions do not substantially change ingrained notetaking behaviors, more drastic action is required, such as providing lecture handouts to guide notetaking.

Providing lecture handouts

A more effective way to improve notetaking is to provide students with some sort of lecture handout to guide their notetaking. In a review of earlier research, Kiewra (1985b) concluded that notetaking could be improved by providing students with partial outlines prior to the lecture. Research had shown that students who take notes on partial outlines generally learn more than students who take conventional, unassisted notes because partial outlines organizing upcoming material focus attention on critical lecture ideas, guide notetaking, and provide effective cues for retrieval of lecture information.

Kiewra and colleagues then embarked on a series of experiments in which they attempted to manipulate notetaking behavior by providing different frameworks for notetaking. Studies by Kiewra et al. (1989) and Kiewra et al. (1991) were discussed earlier but are revisited here with respect to results that are relevant for improving notetaking using lecture handouts.

In the Kiewra et al. (1989) and Kiewra et al. (1991) studies, two types of notetaking frameworks were compared to conventional notetaking, or the student's own style of notetaking without a framework. An outline framework (also called a linear or skeletal framework) lists the main topics and subtopics in outline form, with space for taking notes within the outline. A matrix framework presents the main topics as column headings and the subtopics as row headings, with space in the matrix cells for taking notes.

Kiewra et al. (1989), articulated more completely in Kiewra et al. (1991), posited two theoretical benefits for outline and matrix notes. First, both frameworks should encourage students to take more complete notes, and, as previously discussed, note completeness is positively related to achievement. Both the outline and the matrix provide topics and subtopics, which help students attend to important information; the outline and matrix also provide spaces, which invite notetaking. A second theoretical benefit of outlines and matrices is that they may foster internal connections. Outlines emphasize superordinate-subordinate relationships within topics, while matrices show relationships both within and across topics. A matrix, more than an outline, allows students to synthesize ideas within and across topics.

In Kiewra et al. (1989), the type of notetaking framework influenced the type of notes students took. An analysis of notes taken revealed that skeletal notes contained significantly more idea units than conventional notes, with matrix notes falling in between. Also, notetakers were more efficient (i.e., they used fewer words to express an idea unit) when they used the skeletal and matrix frameworks than when they took conventional

notes. However, Kiewra et al. (1989) failed to find an effect of notetaking framework on any of the four tests of learning outcomes: (a) free recall, (b) factual recognition, (c) synthesis, and (d) application.

Kiewra et al. (1991) found an effect for notetaking framework on type of notes taken as well as learning outcomes. In this study, matrix and linear (or outline) notetaking frameworks resulted in recording significantly more lecture ideas than conventional notetaking. Specifically, matrix notes contained 47% of the lecture ideas, whereas conventional notes contained 32%. Also, matrix notetaking was the most effective of the three notetaking frameworks as measured by a cued recall test of lecture content, but not as measured by a test of synthesis of lecture concepts.

Kiewra, Benton, Kim, Risch, and Christensen (1995) conducted two experiments to investigate how notetaking frameworks influenced student notetaking and learning. In one experiment, students listened to a videotaped lecture and took notes conventionally or on outline or matrix frameworks. Among the relevant results of this experiment was that notetaking on an outline framework increased performance on tests of recall and relational learning, perhaps because outline notetakers took more notes than notetakers in the other two conditions.

The second experiment examined whether various notetaking formats influenced student notetaking. Students were assigned to one of seven notetaking conditions, which included conventional notes, two variations of the outline framework, and four variations of the matrix framework. Students recording notes in a flexible outline (in which subtopics were listed beneath topics in a changing order consistent with their presentation order in the lecture) recorded more notes than students using the other notetaking frameworks. The authors speculated that making the subtopic order of the outline consistent with information presentation in the lecture reduced the students' need to search for the appropriate space to take notes; the flexible outline also provided a cue about the upcoming subtopic. The various matrix formats also produced differences in quantity of notes recorded, with a full matrix producing somewhat greater notetaking than collapsed matrices with fewer subtopics to guide notetaking.

In another study on the effect of providing lecture handouts on learning from lectures, Morgan, Lilley, and Boreham (1988) investigated whether the detail in lecture handouts affected student notetaking as well as their performance on two cued recall tests. Students either took notes with no lecture handout or received one of three lecture handouts prior to the lecture: (a) headings with full lecture text, (b) headings with key points, or (c) headings only. All lecture handouts provided space for students to take notes. The first cued recall test, which was unannounced, was given 2 days after the lecture, and the other test, which was announced, was given 2 weeks after the lecture. Regarding the effect of handouts on notetaking, the researchers found an inverse relationship between the amount of materials in the handout and the amount of notes that students recorded. In other words, the more information students were given, the fewer notes they took.

Regarding the effect of handouts on test performance, Morgan et al. (1988) found that students who had handouts with headings only performed the best on both tests. However, results for other conditions differed depending on time of testing. The authors concluded that handouts must facilitate both encoding and external storage functions of notetaking. The latter function, of course, depends on the amount of detail provided in the notes. Morgan et al. (1988) concluded, however, that more research was needed to tease out the complex relationship between nature of lecture handouts and cognitive processing.

In a study by Cohn et al. (1995), 211 students in a college economics course were randomly assigned to one of eight notetaking conditions. Of relevance here is that, while viewing a 32-minute videotaped lecture, some of the students took notes on blank

paper, others on an outline. Students who took notes on the provided outline took more notes and performed better on a 20-item multiple choice test administered immediately after the lecture than did students who recorded notes on blank paper. The authors concurred with the conclusions of earlier research by Kiewra and colleagues that providing students with a list of lecture topics and subtopics, with space provided for notetaking, improves selective attention and encourages notetaking.

Austin, Lee, Thibeault, Carr, and Bailey (2002) examined the effects of guided notes (a lecture outline with room for students to record key points and examples) on students' responses in class and on their recall of lecture information. There were two experimental conditions: (a) overheads only, in which lecture information was presented in the form of an outline on transparencies, and (b) overheads with guided notes, in which students were given guided notes before the lecture. The guided notes had an outline format with lines to indicate where, when, and how many key concepts to record. Over the course of a semester, 27 undergraduate students listened to lectures that were randomly assigned to either of the experimental conditions, so that all students experienced both types of lectures. Immediate recall of each lecture was assessed by a 5-item quiz. Frequency of student responses was measured by the total number of responses made by each student, as determined from videotapes. The guided notes condition resulted in higher mean quiz recall as well as higher response frequencies (although the latter result is probably due to a higher number of instructor prompts in the guided notes condition). In addition, students reported that they preferred guided notes to traditional notetaking and recommended the use of guided notes in future classes.

Austin, Lee, and Carr (2004) compared the effect of three lecture conditions—traditional lectures (no slides), lectures with slides, and lectures with slides and guided notes—on the quality of students' notes, as measured by the percentage of critical points, examples, and elaborations included in the notes. The lecture condition was assigned randomly over an entire semester, but student notes were collected for scoring after only one lecture in each condition. One result of the study was that the use of slides during a lecture (with or without guided notes) increased the percentage of critical points and examples recorded in notes. A second result was that guided notes improved all measures of note quality. The authors concluded that guided notes are an effective method to encourage students to take notes on important information in lectures.

Williams and Worth (2002) studied the effects of providing students with study guides (a skeletal outline of content) containing questions over class readings, videos, and class discussions. The researchers scored notes taken during reading and in class (with all notes being recorded on the provided study guides) for completeness, length, and accuracy of responses to questions in the study guide. Dependent measures included essay quizzes over readings, group problem solving, a course project, and a total course score. Notetaking during class was the strongest predictor for the combined performance variables. Williams and Worth (2002) attributed this result at least in part to the presence of the study guide, which provided a structured approach to notetaking. The authors further speculated that electronically-transmitted study guides might facilitate notetaking, if students had laptops available during class.

Ruhl and Suritsky (1995) had college LD students view a 22-minute videotaped lecture in one of three conditions: (a) pause procedure (three 2-minute pauses spaced at logical intervals during the lecture), (b) lecture outline (received a lecturer-prepared outline of key points from the lecture), or (c) both pause and lecture outline. Dependent measures included immediate free recall of the lecture, and two measures of note completeness—percentage of total correct information and percentage of partial correct information. Relevant results included the finding that the lecture outline was not as effective as the pause procedure for free recall. With regard to percentage of total correct notes, both the pause procedure and the outline plus the pause were equally effective

and were superior to the outline only. The authors speculated that for LD students, the outline may have distracted students during the lecture, a conclusion confirmed by several students who commented that it was difficult to keep up with the lecture and follow the outline concurrently. Ruhl and Suritsky suggested that LD college students may need direct instruction in how to effectively use outlines provided by instructors. Alternatively, the "flexible" outline used by Kiewra et al. (1995), in which outline topics follow the presentation order of the lecture, might be easier for LD students to use.

In a study by Grabe, Christopherson, and Douglas, (2004-2005), 178 college students had access to two types of online lecture notes: (a) Outline Notes, which were the same notes used to structure class lectures; and (b) Complete Notes, which were notes taken by a teaching assistant assigned to the class, who attempted to summarize the lecture content. Results included the finding that 74% of questionnaire respondents reported accessing online notes, with students viewing Outline Notes significantly more than Complete Notes. Students accessed online notes significantly more during the delivery time of the corresponding lecture, but the researchers did not have the data to determine whether students brought outline notes to class in order to facilitate their notetaking. Regarding performance on three class examinations, students who viewed all Outline Notes scored significantly higher than students who viewed no Outline Notes on two of the examinations, whereas students who viewed all Complete Notes scored significantly higher than students who viewed no Complete Notes on the third examination. Although provision of online notes may benefit class performance, it may have an effect on class attendance, as many students in the study claimed that access to online notes was a "Very Significant" factor in their voluntary absences from class.

Neef, McCord, and Ferreri (2006) compared guided notes to complete notes with respect to performance on delayed quizzes. Over an 8-week period, prior to the week's lecture, 46 graduate students alternately received either complete notes (notes produced from lecture slides) or guided notes (notes identical to complete lecture slides except that blank lines were left for students to record key points). At the beginning of each class period, the students completed a 5-point quiz consisting of items testing knowledge, comprehension, application, analysis, and synthesis of the previous week's lecture content. The results did not reveal consistent differences on mean quiz scores between the two note formats. However, students had fewer errors on the analysis-level questions in the guided notes condition than in the complete notes condition. In addition, students showed a slight preference for guided notes over complete notes, believing that the guided notes helped them follow the lectures and study the material.

In summary, several studies have examined the use of various types of lecture handouts, including structured guides such as outlines, guided notes, and matrices. It appears that such structured notetaking guides help students record more notes and facilitate some types of learning. However, as Morgan et al. (1988) suggested, the relationship between type of lecture handout and cognitive processing is extremely complex and warrants considerably more research.

Varying the lecture

Another approach to improving notetaking is to vary the lecture. Several methods of varying the lecture will be discussed here.

Repeating the lecture

One way to vary a lecture presentation is to repeat it. Drawing on the previously reviewed research that showed a relationship between note completeness and learning, Kiewra and colleagues tried increasing the quantity and quality of notes by repeating a video-

taped lecture presentation. Kiewra (1989) reported a study that he did (Kiewra, Mayer, Christian, Dyreson, & McShane, 1988), in which students took notes while watching a videotaped lecture once, twice, or three times. Students were asked to record different notes each time. Results included the finding that students viewing the lecture three times noted significantly more lecture ideas in their final set of notes (41%) than did students who viewed the lecture only once (32%). Lecture idea units were also classified into three levels of importance. Although students viewing the lecture varying numbers of times did not differ significantly with respect to the most and least important ideas in their notes, students who viewed the lecture three times recorded a significantly greater number of idea units at the middle level of importance (41%) than did students who viewed the lecture only once (34%).

Subsequently, Kiewra, Mayer, Christensen, Kim, and Risch (1991) conducted a similar study. In one experiment, students took cumulative notes on a lecture that was presented once, twice, or three times and took a recall test without review. The second experiment replicated the first except that students were allowed to review their notes. In both experiments, students recorded the most important lecture information on the first viewing, with little representation of less important information. On subsequent viewings, students added less important information but did not add more important information. The authors concluded that students engage in a strategy of successive differentiation. First, they focus on the most important information. When they reach a ceiling on the most important information, they shift attention to less important information.

A study by Kiewra and Mayer (1997) also included a condition of repeated presentations (one to three) of a videotaped lecture. As in previous studies, each repeated presentation increased notetaking and recognition of isolated facts; to some extent, overall recall was also increased through repetition.

Providing lecture cues

Another way to vary lectures is for the lecturer to provide cues to increase the salience of information. Lecture cues are "verbal and nonverbal behaviors used during lectures that serve to heighten students' awareness" (Titsworth, 2004, p. 307). For example, the lecturer may cue information by writing it on the blackboard or by saying something to the effect of "now, this is important." Baker and Lombardi (1985) examined the notes of students who listened to a lecture supplemented by two transparencies that acted as cues. The transparencies contained key words presented in a rough hierarchical structure representing 35 propositions. The researchers found that virtually all students recorded all of the information from the transparencies, but recorded only 27% of additional information identified by the investigators as important. Also, a significant positive relationship existed between notes taken and performance on test items related to the noted information.

Another study examining the effect of cuing was a study by Scerbo et al. (1992). Scerbo and colleagues compared the relative effectiveness of written and spoken cues, as well as investigating cuing schedules, or the timing of cues. Students viewed a 36-minute videotaped lecture in which certain statements were highlighted by either cues spoken by the lecturer or cues written on cue cards. Students were assigned to one of four types of cuing schedules: (a) no cuing, (b) cuing only in initial portion of lecture, (c) cuing only in the final portion of lecture, or (d) cuing throughout. The dependent measures included: (a) the information recorded in notes for each lecture segment, (b) an immediate multiple-choice recognition test, and (c) an immediate fill-in-the-blank recall test.

With regard to information recorded in notes, students in all conditions recorded fewer information units over the course of the lecture. The different cuing schedules did not affect recognition of lecture items, but they did affect recall of information. More written cues were recorded than spoken cues, but the proportion of cued statements recorded decreased over time similarly for both spoken and written cues. More cued statements were retained than uncued statements, and retention was better for written than spoken cues. Finally, the different schedules of cuing had some subtle effects on notetaking and recall. For example, the group that received cues in the first segment only recorded the same number of ideas as the group that received cuing throughout in the second segment of the lecture, but by the third segment, the differences had disappeared. The authors concluded that providing cues, especially written cues, early in the lecture or throughout can facilitate immediate retention of lecture material.

More recently, Titsworth and colleagues have contributed additional research related to lecture cuing. In Titsworth (2001), 223 undergraduates listened to versions of a lecture that contained either organizational cues or no cues; the students either took or did not take notes. Subjects completed an immediate test after a 5-minute review period and a delayed test after 1 week; the tests consisted of factual recall (filling in details in an organizational framework for the lecture) and conceptual knowledge (15 multiple-choice items requiring recognition and application of theories). Relevant results were that organizational cues and notetaking each had positive effects on students' learning and that test performance was higher when the lecture contained organizational cues *and* students took notes.

A study by Titsworth and Kiewra (2004) addressed the questions of whether oral organizational cues in a lecture aided notetaking and whether lecture cues and notetaking promoted achievement. Sixty undergraduate students listened to either cued or uncued versions of an approximately 15-minute audiotaped lecture about four theories of human communication. The cued version contained two types of organizational cues for the content—an advance organizer giving an overview of the organization of the upcoming lecture, and organizational cues (e.g., verbally emphasizing important information and announcing shifts to new topics) that were interspersed throughout the lecture. The uncued version was identical in content but omitted the organizational cues. Half of the subjects took notes, and the other half did not. After 5 minutes of review (either with or without notes), students took two tests: (a) An "organizational test" asked them to identify all lecture topics and all subcategories of each topic, (b) a "detail test" asked students to fill details in a blank matrix with theories as column headings and subcategories as row headings. Confirming earlier studies that notetaking boosts achievement, Titsworth and Kiewra found that students who took notes recalled about 13% more than students who did not take notes. In addition, hearing a lecture with spoken organizational cues boosted notetaking dramatically. Compared to students listening to the uncued lectures, students who heard the cued lecture recorded about 60% more of the lecture points—four times as many organizational points and twice as many details.

Titsworth (2004) investigated the effect of two types of lecture cues on students' notetaking. The first type was organizational cues similar to those in the Titsworth and Kiewra (2004) study. The second type was immediacy or behaviors that engender psychological closeness with students. In this study, 104 undergraduate students listened to one of four versions of a 170-minute videotaped lecture. The lecture contained either strong or weak organizational cues and either high or low immediacy. In high immediacy lectures, the teacher employed "we" statements and vocal variation, moved around, and used facial expression and direct eye contact, while in low immediacy lectures, these aspects were absent. After a 5-minute review period following the lecture, students completed three tests: (a) a test of conceptual knowledge, (b) an organization

test of their ability to produce an outline of the lecture without reference to notes, and (c) a detail test. As in previous studies by this researcher, lectures with prominent organizational cues resulted in students recording more organizational points and details. There was also a small significant negative effect for teacher immediacy on students' recording of lecture details. As Titsworth suggests, students may fail to attend to lecture content because they become so involved with the teacher's delivery. Finally, and again consistent with previous findings, both the number of organizational points and details recorded in notes were positively related to students' test performance.

Pauses in lectures

Another method of varying the lecture that has been investigated to some extent is the *pause procedure.* This procedure entails pausing for brief periods of time during the lecture to permit student discussion and clarification of lecture content and updating of notes. Theoretically, such pauses could reduce the cognitive demands of the encoding function of notetaking, thereby enabling students to take more and better notes, as well as to engage in more generative processing of lecture content.

Among the researchers to explore the pause procedure are Ruhl, Hughes, and Gajar (1990), who have focused in particular on the effectiveness of the pause procedure for LD college students. Ruhl and colleagues presented videotaped lectures with and without pauses to both LD and ND college students. During lecture pauses LD and ND students worked in pairs to discuss lecture content, clarify concepts, or correct notes. Lectures were followed by immediate free recall tests; 1 week later, students completed a delayed free recall test and a multiple-choice test about lecture content. Students were instructed not to study for the delayed tests. Results indicated that the pause procedure significantly improved students' performance on the immediate free recall and objective tests, but not on the delayed free recall test. The authors concluded that the pause procedure may be effective for both LD and ND college students, at least for some kinds of learning measures.

Ruhl (1996) undertook a study of the notes and immediate recall of 26 LD college students assigned to two different activities during lecture pauses. During three 2-minute lecture pauses occurring in a 22-minute videotaped lecture, students either discussed or did not discuss the lecture with fellow students. At the conclusion of the lecture, students completed a free recall of the content. Results indicated that pause with discussion resulted in notes containing fewer fully included ideas and more partially recorded ideas than pauses without discussion. Additional results included the typical positive relationship between note completeness and recall. Ruhl concluded that peer collaboration may have precluded an opportunity to review notes and/or complete partially noted ideas.

Ruhl and Suritsky (1995) performed another study of the pause procedure, which has already been discussed in the section on lecture handouts. Recall that Ruhl and Suritsky (1995) had college LD students view a 22-minute videotaped lecture in one of three conditions: (a) pause procedure (three 2-minute pauses spaced at logical intervals during the lecture), (b) lecture outline (received a lecturer-prepared outline of key points from the lecture), or (c) both pause and lecture outline. The students in the pause groups were briefly trained to use the pauses to update notes and to clarify and discuss the lecture content with randomly assigned, ND peers who had access to full lecture notes. Dependent measures included immediate free recall of the lecture and two measures of note completeness—percentage of total correct information and percentage of partial correct information. Results included the finding that the pause procedure alone was the most effective for free recall. With regard to percentage of total correct notes, both the pause procedure and the outline plus the pause were equally effective, and both were superior

to the outline only. Therefore, this study also suggested that the pause procedure may be an effective way to improve notetaking by varying the lecture.

In another variation of the pause procedure, Davis and Hult (1997) investigated the effect of writing summaries during lecture pauses. Seventy-nine students enrolled in an introductory psychology course took notes during a 21-minute videotaped lecture divided into three 7-minute segments. One group wrote summaries of the preceding lecture material during pauses between the lecture segments while another group only reviewed their notes during pauses. A control group took notes with no lecture pauses. Immediately following the lecture, students completed a 20-item, multiple-choice posttest. Twelve days later, they took a parallel form of the immediate posttest and answered a free recall question. Although there was no significant difference among the 3 groups on the immediate test, the group that wrote summaries performed significantly better than the control group on both delayed measures. As the authors suggest, summary writing during a lecture may result in more durable learning for at least two reasons. First, writing a summary is a generative activity because it requires students to synthesize and reorganize information. Second, the directions to write a summary may have served as an advance organizer, cuing students to attend to main ideas.

Using computers to supplement instruction

A final possibility for improving notetaking by varying the lecture is through computer-aided lecturing. In computer-aided lecturing, a computer and electronic presentation software are used to link topics found in various media sources (film, video, audio, text, animation, etc.). With the exploding development of multimedia software, college instructors are turning to computer technology to supplement their lectures in an attempt to facilitate comprehension and learning. Theoretically, computer-aided lecturing could help students make internal and external connections, thus improving their generative processing of lecture content.

Unfortunately, little research on computer-aided lecturing has been published to date. Van Meter (1994) conducted a survey study of students in an introductory natural resource conservation course that employed a computer-aided lecture. According to the survey results, 94% of the 48 respondents believed that the computer-aided lecture helped them. Also, 79% of the students believed their notetaking would not have been as effective if the lecture material had been presented on a blackboard rather than by computer, whereas 62% of the students believed that their notetaking would have been less effective if the material had been presented by an overhead projector rather than by a computer.

Providing technological aids to notetaking

A potential way to improve the notes that students take is to provide them with technological tools for recording notes. Given that transcription fluency predicts note quality (Peverly et al., 2007), if students can keyboard faster than they can write, they should be able to record more complete and higher quality notes using a laptop. In the one research study I could find that is somewhat related to this topic, Hembrooke and Gay (2003) investigated the effects of "multitasking" by using a laptop while listening to a lecture in a communications course. In one experiment, 44 students heard the same lecture. Half of the students were allowed to use laptops for browsing, search, or social communication (not for notetaking, however); the other half kept their laptops closed. On a 20-item test consisting of 10 multiple-choice and 10 short-answer recall questions administered immediately after the lecture, students in the open laptop condition performed less well than students who did not use a laptop. A second experiment replicated

the results of the first. The researchers could also track how students spent time on the computer. Students who browsed class-related pages actually had lower scores than students who browsed unrelated pages. Therefore, performance was apparently based not on relevance of computer use to the lecture content, but on the proportion of time spent "multitasking" between attending to the lecture and the laptop. Hembrooke and Gay concluded that classrooms with wireless access "have the potential to bring distraction to new heights" (p. 47). Although this study did not examine the use of laptops to record notes, it suggests the possibility that students may use laptops for purposes that actually compete with encoding the lecture content.

So far this section has discussed research on improving the notes that students take. The possibilities for improving notetaking that have been researched include giving simple verbal directions, providing lecture handouts of various types, varying the lecture through repetition, cuing important information, and pausing periodically. (Using computer technology may be another option, but, to my knowledge, research on this topic has not been published to date.) Besides improving notetaking, another possibility for improving learning from lectures is to assist students (post lecture) in reviewing lecture content.

Reviewing lecture content

Two ways to enhance the review of lecture content have been explored in notetaking research—improving the content students have available for review and improving the method students use to review the content. Research on each of these methods is discussed next.

Improving content for review

Because students do not take very complete or accurate notes, one possible way to improve learning from lectures is to provide students with some form of supplemental notes, such as a full transcript of the lecture provided by the instructor. Research on the relative effectiveness of personal lecture notes versus full instructor's notes was reviewed by Kiewra (1985b). Kiewra concluded that when lectures are followed by immediate review and testing, full lecture notes are not as effective as personal lecture notes, perhaps because the process of reviewing the instructor's notes may have interfered with the initial processing of lecture information. However, if there is a delay between lecture and review/testing, full instructor notes are beneficial for acquisition of factual knowledge, presumably because the instructor's notes are more complete and better organized.

On measures of higher-order learning (application, analysis, synthesis, problem-solving), however, Kiewra (1985b), citing three of his own studies, found no differences between reviewing students' own and instructor-provided notes. Kiewra speculated that the instructor's notes provided no advantage for higher-order learning because students did not process them generatively during review. In other words, the instructors did not provide internal connections in the notes, and students did not spontaneously provide either internal or external connections.

In his review of previous research on reviewing notes, Kiewra (1985b) also concluded that reviewing both complete instructor notes and personal notes promotes higher achievement than reviewing only one of these. Reviewing both sets of notes combines the advantages of both completeness and accuracy of information with possibilities for generative learning. Finally, Kiewra noted that, although researchers had explored the effect on notetaking and learning of providing students with partial outlines prior to the lecture, research had not yet compared the review benefits of skeletal notes with the benefits of personal notes or full instructor notes.

Kiewra and his colleagues then set out to compare the benefits of various types of notes available for review. In Kiewra et al. (1988), college students viewed a 19-minute videotaped lecture without taking notes. One week later, students were given a 25-minute review period in which they either mentally reviewed (no notes) or reviewed one of three types of notes: (a) a complete transcript of the lecture, (b) notes in outline form, or (c) notes in matrix form (with outline and matrix defined as in the Kiewra et al. [1989] studies previously discussed). Following the review period, the students completed three types of tests—cued recall, recognition, and transfer (synthesis and application). One result was that reviewing any of the three forms of notes was better than mental review (review with no notes). This result, of course, is further confirmation of the value of the external storage function of notetaking. A second result was that both outline and matrix notes produced higher recall than the full transcript. The authors speculated that both outline and matrix notes helped the learner make internal connections among ideas, thus facilitating retrieval. A third result was that only the matrix notes produced significantly higher transfer performance. The researchers suggested that matrix notes allowed a more fully integrated understanding of the content (i.e., both internal and external connections), which facilitated performance on transfer tasks involving synthesis and application. Finally, the three note-reviewing groups performed similarly on the factual recognition test, apparently because these items involved the recognition of isolated facts, which is less likely to be influenced by forming internal connections.

In the previously discussed Benton et al. (1993) study, which used essay writing as the criterion task, two results are relevant to this discussion. Recall that in Experiment 4, students who had not taken notes were given either no notes or notes in one of three notetaking frameworks (conventional, outline, matrix) prior to writing a compare-contrast essay 1 week after the lecture. Among the results of that experiment was the finding that students who were given outline or matrix notes included more text units in their essays. Also, students provided with matrix notes wrote more coherent essays. These results suggest that, given a delay between the lecture and the time of writing, providing students with organized notes helps them write longer and more organized essays of lecture content.

In summary, research suggests that the type of notes students have available for review makes a difference in learning, especially as time elapses between the lecture and review/testing. Because students do not record very complete or accurate notes on their own, some form of supplemental notes can be helpful for review in preparation for taking a test or writing an essay. A complete transcript of the lecture may facilitate factual learning. For higher-order learning and transfer, however, including essay writing or notes that invite generative processing, such as outline and matrix notes, are likely to be the most effective.

Improving method of review

Another approach to improving learning from lectures is to address the method of review, or what students actually do during study sessions. Methods of reviewing lecture content have received little research attention. One researcher who has completed noteworthy research in the area, however, is King (1989, 1991, 1992). Although the first two studies reviewed here do not involve notetaking, they do involve learning from lectures, and they are important background for the third study, which does include notetaking.

In her series of studies, King has adapted self-questioning research conducted in the area of reading to orally presented material. In King (1989), college students were assigned to one of four groups: (a) independent review, (b) independent self-questioning, (c) review in small, cooperative groups, and (d) self- and peer-questioning in small

cooperative groups. Students in the self-questioning groups received direct instruction in a self-questioning procedure involving the use of generic question starters to guide them in asking higher-order comprehension questions. Examples of the generic question starters include "Explain why ____," "How does ____ affect ____?" and "What do you think would happen if _____?"

The study took place over a series of six lectures in a regular college course. After each lecture, students participated in 10- to 12-minute "study sessions" according to their treatment group, and then completed a comprehension test over the lecture content. The first lecture was followed by a pretest, and the last lecture by a posttest. All tests consisted of multiple-choice and open-ended questions eliciting higher order thinking (integration, elaboration, analysis, application). Results indicated that both self-questioning independently and in small cooperative groups significantly improved lecture learning over the course of the study. King (1989) attributed the success of the self-questioning strategy to the metacognitive effects of self-questioning—that is, the benefits of comprehension monitoring during learning. King further speculated that the self-questioning training may have improved students' initial encoding of the lecture.

King (1991) extended her investigation of the self-questioning technique to a younger population of ninth graders. (Despite the focus on college learners in this volume, this study with a younger population is included because it replicates King's findings with college students.) In the 1991 study, ninth graders were assigned to one of four groups: (a) self-questioning with reciprocal peer questioning, (b) self-questioning only, (c) discussion, and (d) independent review (control). Students in the two self-questioning conditions were provided with direct instruction in asking higher-order questions, as described for the previous study. Students in the self-questioning with reciprocal peer questioning group were instructed to independently generate questions during the lecture and then to spend their 12-minute study session posing their questions to the other members of their cooperative learning groups and discussing possible answers. The self-questioning-only students used their study session time to write down the questions they had generated during the lecture and then answer them independently. Students in the discussion group listened to the lecture, followed by unguided discussion; students in the control group listened to the lecture and reviewed the material according to their preferred review strategy.

On postpractice and maintenance tests consisting of multiple-choice and open-ended questions eliciting higher order thinking (integration, elaboration, analysis, application), both questioning groups outperformed discussion review and independent review groups. Again, King attributed the results to the facilitation of metacognition in the self-questioning groups. With both ninth grade and college populations, King (1989, 1991) demonstrated that a self-questioning strategy was not only effective in enhancing learning from lectures, but that it could also be readily taught and successfully maintained over time.

King (1992) directly compared self-questioning to other common lecture review strategies of college students. College students viewed a videotaped lecture, took notes in their usual fashion, and then engaged in one of three study strategies: (a) self-questioning, (b) summarizing, and (c) reviewing own notes (control). The self-questioning group was trained as described in the previous King studies (1989, 1991). The summarizing group was trained to generate a sentence, using their own words, about the main topic of the lecture, followed by other sentences connecting subtopics and main ideas.

There were several important results from the study. First, regarding learning from lectures, it was found that on an immediate recall test, summarizers recalled more than self-questioners, who in turn recalled more than those who reviewed their own

notes. On a 1-week delayed recall test, the self-questioners somewhat outperformed (nonsignificantly) the summarizers; however, the self-questioners significantly outperformed the note reviewers. An analysis of lecture notes revealed that self-questioners and summarizers included more ideas from the lectures than did students who took notes in their usual fashion, suggesting that the strategies affect initial encoding as well as review. In other words, given well-designed training, both guided self-questioning and summarizing are effective strategies for learning from lectures, more effective than simply taking notes and reviewing one's own notes. It appears that, the longer the delay from lecture to testing, the more pronounced the effectiveness of self-questioning over summarizing.

King (1992) attributed these results to the generative nature of these strategies. Both summarizing and self-questioning require students to construct their own representations of lecture meaning, both during the lecture and when reviewing the lecture. According to King, the summarizing strategy helped students make internal connections among lecture ideas, whereas self-questioning promoted both internal and external connections and was thus the more powerful of the two strategies.

Another study focusing on the review of lecture content was conducted by O'Donnell and Dansereau (1993). These researchers investigated individual versus cooperative review involving pairs of students. In cooperative review, one partner, the "recaller," attempts to recall from memory (without referring to notes) everything he or she can remember from the lecture, while a "listener," who has access to notes, listens carefully and reports errors or omissions in the recall of the recaller.

In the O'Donnell and Dansereau study, college students listened to a 25-minute audiotaped lecture in one of four treatments: (a) students who took notes and reviewed them individually immediately after the lecture; (b) pairs of students who took notes and were told to expect to cooperatively review the notes immediately after the lecture; (c) pairs of students, where one listened to the lecture without taking notes and subsequently summarized the information to a partner who took notes during the lecture; and (d) pairs of students who took notes during the lecture without expecting to review cooperatively, but who, in fact, did have an opportunity for cooperative review immediately following the lecture. Students were tested on their free recall of the lecture 1 week following the lecture, without a second period for review, and their recall protocols were scored for recall of central ideas and details.

Results included the finding of no significant differences for recall of central ideas. However, for recall of details, students who expected to review individually but who actually reviewed with a partner recalled more than students who reviewed alone. Furthermore, partners who did not take notes but reviewed cooperatively recalled as much as their partner who did take notes. Partners who did not take notes but reviewed cooperatively also recalled as much as students who took notes and reviewed them on their own. These results suggested to the authors that the facilitative effects of cooperative review are primarily due to the review itself, rather than to differential encoding.

In summary, two possibilities for improving students' review of notes have been investigated—improving the content students have to review and improving the method of review. Because students tend to be poor notetakers, supplementing the notes they have available for review is useful. The supplemental notes may be full transcripts of the lecture or other forms of notes, such as outline notes or matrix notes. Full-instructor notes can facilitate factual learning, while outline or matrix notes may be more beneficial for higher-order learning. Regarding method of review, researchers have found positive results with variations of cooperative review, in which students work together to review lecture content.

CONCLUSION

Guided by cogn
ing notes from l
primarily to the
clarified the fun
storage to the o
and Gray (1972)
of taking notes li
between the lectu
types of notes st
differences, parti
have explored sev
ing from lectures
practice, as well a

RECOMMENDA

Research has con
is related to their
such a complex, c
Research has sugg
ing of notes.

One way to im
lecture handouts
Theoretically, the
tion, provide guid
guided notes can
review by helping
found that outline
sentation), and ma
some types of lea
types of students,
more precise reco
tionships between

Another way to
alteration is simpl
ings. As students
tion, particularly i
have more opportu
notetaking is prob
to be videotaped a
accessing video ca
videotapes. Third,
listen to a lecture n

Other ways of v
cedure, providing
methods seem pro
research on each o
for practice.

CONCLUSIONS

Guided by cognitive-constructivist and generative views of learning, research on taking notes from lectures has moved forward significantly in the past 25 years, thanks primarily to the work of Kenneth Kiewra and colleagues. Kiewra reconceptualized and clarified the functions of notetaking, adding the function of encoding plus external storage to the original encoding and external storage functions proposed by DiVesta and Gray (1972). The research of Kiewra and others has confirmed that the real value of taking notes lies in having them available for review, especially with increased time between the lecture and the criterion task. Researchers have discovered more about the types of notes students take when left to their own devices, as well as how individual differences, particularly in cognition, affect notetaking behavior. Finally, researchers have explored several ways to facilitate notetaking and review in order to improve learning from lectures. The research reviewed in this chapter has important implications for practice, as well as suggesting several areas where further research is needed.

RECOMMENDATIONS FOR PRACTICE

Research has confirmed that the quantity and quality of the notes that students take is related to their achievement. Unfortunately, because taking notes during lectures is such a complex, cognitively demanding task, students do not take very effective notes. Research has suggested some ways to improve both the taking of notes and the reviewing of notes.

One way to improve notetaking is to provide lecture handouts. Three main types of lecture handouts investigated in recent years are outlines, matrices, and guided notes. Theoretically, these types of handouts serve as advance organizers, focus student attention, provide guides for notetaking, and give retrieval cues. Outlines, matrices, and guided notes can also encourage generative processing during both notetaking and review by helping students make internal and external connections. Several studies have found that outlines, guided notes (especially when they follow the order of lecture presentation), and matrices can help students take more complete notes and can facilitate some types of learning. These lecture handouts may be especially helpful for certain types of students, such as field-dependent learners. However, it is not possible to make more precise recommendations until further research has teased out the complex relationships between notetaking format and cognitive processing.

Another way to improve notetaking is to make changes in the lecture. The easiest alteration is simply to videotape the lecture and make it available for repeated viewings. As students view the lecture repeatedly, they are able to record more information, particularly information at lower levels of importance. Theoretically, students also have more opportunity for generative processing at encoding. This way of improving notetaking is probably not very practical, however. First, instructors may prefer not to be videotaped as they lecture. Second, there may be logistical impediments, such as accessing video cameras and technicians, as well as copying and providing access to videotapes. Third, most students probably have neither the time nor the motivation to listen to a lecture more than once.

Other ways of varying the lecture that have been explored include the pause procedure, providing written or oral cues, and computer-aided lecturing. Although these methods seem promising, perhaps especially for certain populations of college students, research on each of these methods is too sparse to warrant specific recommendations for practice.

Besides improving notetaking, learning from lectures can also be enhanced by improving how the lecture content is later reviewed. One way to strengthen review is to improve the content students have to review, especially as time elapses between the lecture and the time of review and testing. Interestingly, more is not necessarily better. That is, providing a complete transcript of the lecture may only be effective for improving factual learning. For higher-order learning and transfer, including essay writing or answering analysis-level questions, providing outline, guided, or matrix notes is likely to be more helpful, perhaps because these forms of notes encourage more generative processing.

Another way to improve review is to improve the method students use to review. The methods that have yielded positive results to date involve some form of cooperative review. Training students to work together to ask and answer higher-order, open-ended questions or to generate summaries based on the lecture appear to be promising strategies. Once again, however, more research is needed, which brings us to the final section of this chapter.

FUTURE RESEARCH AVENUES

With any luck, Kiewra has laid to rest the debate about the functions of notetaking. It seems clear that both the encoding and external storage functions of notetaking are important for learning. Furthermore, taking and reviewing notes is simply a practical reality. Unless and until lectures are replaced with more effective pedagogical tools, college students are likely to continue both to take notes and to review them prior to course examinations. Therefore, it seems important for research to focus more on how to improve the encoding and external storage functions with respect to various types of learners and learning outcomes.

Regarding ways to improve notetaking, lecture handouts seem relatively practical and promising. As noted, however, the relationship between type of lecture handout and cognitive processing is very complex, and much research remains to be done. Kiewra and colleagues' work in exploring the effect of different types of outlines and matrices needs to be extended. It is also important to explore other ways of representing lecture content. Matrices, for example, are useful for, but restricted to, portraying multiple attributes of multiple concepts. Lecture content that is organized in different ways might be represented by different types of graphic organizers, such as hierarchical trees or flow charts.

Other research on notetaking might investigate ways to train students to become more strategic notetakers. Courses and manuals on study skills, as well as articles in professional journals (e.g., Stahl, King, & Henk, 1991), address notetaking, but little if any research on the effectiveness of such instruction exists. It might be fruitful to pursue research on students' mental models of learning from lectures (Ryan, 2001). If some models prove to be more beneficial than others, then perhaps students could be taught notetaking practices consistent with the more effective models. Also, it seems likely that the kind of systematic, direct instruction and "informed strategy training" (e.g., Palincsar & Brown, 1984; Paris, Cross, & Lipson, 1984) that has been successfully used to teach various cognitive strategies, such as King's self-questioning during review (King, 1989, 1991, 1992), should be applied to teaching notetaking strategies as well.

Reviewing notes is an area that seems particularly ripe for research. Existing research seems silent on what students do when they review their notes prior to an examination. Therefore, naturalistic research on students' actual process of reviewing would be helpful. Research is also needed on the placement and length of review activities. For

example, when should review occur with respect to the lecture? The exam? How many times should notes be reviewed, and for how long?

There is also a great deal of research to be done on ways to improve review. More research on the cooperative review methods discussed previously would be welcome. But researchers also need to address methods that individuals can pursue in reviewing lecture content. For example, elaborating or transforming notes in some way might be a useful generative review activity. Writing an essay is an example of an activity that could be done not only as a criterion task, but also as a way of reviewing notes.

In future research on improving notetaking and review, researchers need to pay heed to the criterion tasks they use as measures of learning. Kiewra et al. and King, for example, are to be commended for including multiple measures of learning, from factual learning to higher-order learning, such as synthesis, application, and problem-solving. Nevertheless, these are still paper-and-pencil measures, as typically found on college course examinations. Future research needs to include other kinds of learning outcomes. Because lectures are often used in the workplace as well, it is increasingly important to use workplace-like criterion tasks, perhaps including performance-based tasks such as writing a report or implementing a procedure.

The role of computer technology in lecturing, notetaking, and reviewing is an obvious candidate for more research. For example, in computer-aided lecturing, does linking topics from various media sources facilitate forming internal and external connections, or does it result in information and cognitive overload, thus rendering notetaking even more difficult? Another question concerns the use of computers, especially laptops, as notetaking aids. I was astonished to find no published research on the use of computers for notetaking from lectures, although there is research on taking notes from computer-based instruction (CBI) (e.g., Armel, 1995; Quade, 1995, 1996). Many questions in the area need to be addressed, for example: Are laptops in the lecture helpful or distracting? Does computer notetaking improve the quantity and quality of the notes students take? Does it make it easier for students to manipulate or elaborate notes during review, and if so, to what effect? Finally, what effect might computers have on reviewing lecture content? For example, what role could e-mail, chat rooms, list serves, or other online discussion groups play in helping students review?

Finally, research on individual differences in notetaking and review seems critically important. Researchers have investigated the effect of several cognitive variables on notetaking from lectures, but much research remains to be done. For example, researchers at Penn State (e.g., Ruhl et al., 1990; Suritsky & Hughes, 1991; Hughes & Suritsky, 1993; Ruhl & Suritsky, 1995) made a compelling case for more research addressing the needs of increasing numbers of LD college students who experience significant difficulties taking notes from lectures. In addition, with the increasing linguistic diversity of the U.S. population and the large numbers of international students enrolled in U.S. colleges and universities, it seems essential for researchers to address the needs of non-native speakers of English as they take notes. Conversely, it might be interesting to study notetaking of native speakers of English as they attempt to take notes from international professors and teaching assistants.

In addition to cognitive variables, research might investigate other variables that affect notetaking. Among the candidate variables might be whether students have received instruction in notetaking or have simply learned it on their own, motivation (intrinsic and extrinsic) to learn lecture content, attention, college major, writing skills, and so on.

In closing, research has revealed much about the functions of notetaking and how to improve notetaking, but there is still much to be learned about notetaking as a tool for learning from college lectures.

REFERENCES AND SUGGESTED READINGS

Anderson, T. H., & Armbruster, B. B. (1986). *The value of taking notes.* (Reading Education Report No. 374). Champaign: University of Illinois at Urbana-Champaign, Center for the Study of Reading.

Armel, D. (1995). Something new about notetaking: A computer-based instructional experiment. In *28th Proceedings of the Association of Small Computer Users in Education (ASCUE).* Myrtle Beach, SC.

Austin, J., Lee, M., & Carr, J. (2004). The effects of guided notes on undergraduate students' recording of lecture content. *Journal of Instructional Psychology, 31,* 314–320.

Austin, J. L., Lee, M. G., Thibeault, M. D., Carr, J. E., & Bailey, J. S. (2002). Effects of guided notes on university students' responding and recall of information. *Journal of Behavioral Education, 11,* 243–254.

Baker, L., & Lombardi, B. R. (1985). Students' lecture notes and their relation to performance. *Teaching of Psychology, 12,* 28–32.

Benton, S. L., Kiewra, K. A., Whitfill, J. M., & Dennison, R. (1993). Encoding and external-storage effects on writing processes. *Journal of Educational Psychology, 85,* 267–280.

Carrier, C. A. (1983). Notetaking research: Implications for the classroom. *Journal of Instructional Development, 6,* 19–26.

Carrier, C. A., Williams, M. D., & Dalgaard, B. R. (1988). College students' perceptions of notetaking and their relationship to selected learner characteristics and course achievement. *Research in Higher Education, 28,* 223–239.

Cohn, E., Cohn, S., & Bradley, J. (1995). Notetaking, working memory, and learning principles of economics. *Journal of Economics Education, 26,* 291–307.

Davis, M., & Hult, R. E. (1997). Effects of writing summaries as a generative learning activity during note taking. *Teaching of Psychology, 24*(1), 47–49.

deWinstanley, P. A., & Bjork, R. A. (2002). Successful lecturing: Presenting information in ways that engage effective processing. *New Directions for Teaching and Learning, 89,* 19–31.

DiVesta, E. J., & Gray, G. S. (1972). Listening and notetaking. *Journal of Educational Psychology, 64,* 321–325.

Dunkel, P., & Davy, S. (1989). The heuristic of lecture notetaking: Perceptions of American and international students regarding the value & practice of notetaking. *English for Specific Purposes, 8,* 33–50.

Dunkel, P, Mishra, S., & Berliner, D. (1989). Effects of note taking, memory, and language proficiency on lecture learning for native and normative speakers of English. *TESOL Quarterly, 23,* 543–549.

Eggert, A. C. (2000). An investigation of notetaking as a predictor of course performance and course (sic). Unpublished doctoral dissertation. The University of Tennessee.

Einstein, G. O., Morris, J., & Smith, S. (1985). Note-taking, individual differences, and memory for lecture information. *Journal of Educational Psychology, 77,* 522–532.

Frank, B. M. (1984). Effect of field independence-dependence and study technique on learning from a lecture. *American Educational Research Journal, 21,* 669–678.

Gagne, R. M. (1965). *The conditions of learning.* New York: Holt, Rinehart & Winston.

Grabe, M., Christopherson, K., & Douglas, J. (2004–2005). Providing introductory psychology students access to online lecture notes: The relationship of note use to performance and class attendance. *Journal of Educational Technology Systems, 33,* 295–308.

Hadwin, A. F., Kirby, J. R., & Woodhouse, R. A. (1999). Individual differences in notetaking, summarization, and learning from lectures. *The Alberta Journal of Educational Research, 45,* 1–17.

Hartley, J. (1983). Notetaking research: Resetting the scoreboard. *Bulletin of the British Psychological Society, 36,* 13–14.

Hembrooke, J., & Gay, G. (2003). The laptop and the lecture: The effects of multitasking in learning environments. *Journal of Computing in Higher Education, 15*(1), 46–64.

Hughes, C. A., & Suritsky, S. K. (1993). Notetaking skills and strategies for students with learning disabilities. *Preventing School Failure, 38,* 7–11.

Kiewra, K. A. (1984). The relationship between notetaking over an extended period and actual course-related achievement. *College Student Journal, 17,* 381–385.

*Kiewra, K. A. (1985a). Investigating notetaking and review: A depth of processing alternative. *Educational Psychologist, 20,* 23–32.

Kiewra, K. A. (1985b). Providing instructor's notes: An effective addition to student notetaking. *Educational Psychologist, 20,* 33–39.

Kiewra, K. A. (1985c). Students' note-taking behaviors and the efficacy of providing the instructor's notes for review. *Contemporary Educational Psychology, 10*, 378–386.

*Kiewra, K. A. (1989). A review of note-taking: The encoding-storage paradigm and beyond. *Educational Psychology Review, 1*, 147–172.

Kiewra, K. A., & Benton, S. L. (1988). The relationship between information-processing ability and notetaking. *Contemporary Educational Psychology, 13*, 33–44.

Kiewra, K. A., Benton, S. L., Kim, S-I., Risch, N., & Christensen, M. (1995). Effects of note-taking format and study technique on recall and relational performance. *Contemporary Educational Psychology, 20*, 172–187.

Kiewra, K. A., Benton, S. L., & Lewis, L. B. (1987). Qualitative aspects of notetaking and their relationship with information-processing ability and academic achievement. *Journal of Instructional Psychology, 14*, 110–117.

Kiewra, K. A., & Fletcher, J. J. (1984). The relationship between levels of notetaking and achievement. *Human Learning, 3*, 273–280.

Kiewra, K. A., DuBois, N. F, Christian, D., & McShane, A. (1988). Providing study notes: Comparison of three types of notes for review. *Journal of Educational Psychology, 80*, 595–597.

*Kiewra, K. A., DuBois, N. E, Christian, D., McShane, A., Meyerhoffer, M., & Roskelley, D. (1991). Note-taking functions and techniques. *Journal of Educational Psychology, 83*, 240–245.

Kiewra, K. A., DuBois, N. F, Christensen, M., Kim, S-I., & Lindberg, N. (1989). A more equitable account of the note-taking functions in learning from lecture and from text. *Instructional Sciences, 18*, 217–232.

*Kiewra, K. A., & Frank, B. M. (1986). Cognitive style: Effects of structure at acquisition and testing. *Contemporary Educational Psychology, 11*, 253–263 .

Kiewra, K. A., & Frank, B. M. (1988). Encoding and external-storage effects of personal lecture notes, skeletal notes, and detailed notes for field-independent and field-dependent learners. *Journal of Educational Research, 81*, 143–148.

Kiewra, K. A., & Mayer, R. E. (1997). Effects of advance organizers and repeated presentations on students' learning. *Journal of Experimental Education, 65*, 147–159.

Kiewra, K. A., Mayer, R. E., Christian, D., Dyreson, M., & McShane, A. (1988, April). Quantitative and qualitative effects of repetition and note-taking on learning from videotaped instruction. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Kiewra, K. A., Mayer, R. E., Christensen, M., Kim, S.I., & Risch, N. (1991). Effects of repetition on recall and notetaking: Strategies for learning from lectures. *Journal of Educational Psychology, 83*, 120–123.

King, A. (1989). Effects of self-questioning training on college students' comprehension of lectures. *Contemporary Educational Psychology, 14*, 366–381.

King, A. (1991). Improving lecture comprehension: Effects of a metacognitive strategy. *Applied Cognitive Psychology, 5*, 331–346.

King, A. (1992). Comparison of self-questioning, summarizing, and notetaking-review as strategies for learning from lectures. *American Educational Research Journal, 29*,303–323.

Mayer, R. E. (1984). Aids to text comprehension. *Educational Psychologist, 19*, 30–42.

Morgan, C. H., Lilley, J. D., & Boreham, N. C. (1988). Learning from lectures: The effect of varying the detail in lecture handouts on note-taking and recall. *Applied Cognitive Psychology, 2*, 115–122.

Neef, N. A., McCord, B. E., & Ferreri, S. J. (2006). Effects of guided notes versus completed notes during lectures on college students' quiz performance. *Journal of Applied Behavior Analysis, 39*, 123–130.

O'Donnell, A., & Dansereau, D. F (1993). Learning from lectures: Effects of cooperative review. *Journal of Experimental Education, 61*, 116–125.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and monitoring activities. *Cognition and Instruction, 1*, 117–175.

Paris, S., Cross, D., & Lipson, M. (1984). Informed strategies for learning: A program to improve children's reading awareness and comprehension. *Journal of Educational Psychology, 76*, 1239–1252.

Peper, R. J., & Mayer, R. E. (1986). Generative effects of note-taking during science lectures. *Journal of Educational Psychology, 78*, 34–38.

Peverly, S. T., Ramaswamy, V., Brown, C., Sumowski, J., Alidoost, M., & Garner, J. (2007). What predicts skill in lecture note taking? *Journal of Educational Psychology, 99*, 167–180.

Phillips, D. C. (Ed.). (2000). *Constructivism in education*. Chicago: National Society for the Study of Education.

Piolat, A., Olive, T., & Kellogg, R. T. (2005). Cognitive effort during notetaking. *Applied Cognitive Psychology, 19*, 291–312.

Putnam, M. L., Deshler, D. D., & Schumaker, J. B. (1993). The investigation of setting demands: A missing link in learning strategy instruction. In L. S. Meltzer (Ed.), *Strategy assessment and instruction for students with learning disabilities* (pp. 325–354). Austin, TX: PRO-ED.

Quade, A. M. (1995). A comparison of on-line and traditional paper and pencil notetaking methods during computer-delivered instruction. In *17th Proceedings of the Annual National Convention of the Association for Educational Communications and Technology (AECT)*. Anaheim, CA.

Quade, A. M. (1996). An assessment of retention and depth of processing associated with notetaking using traditional pencil and paper and an on-line notepad during computer-delivered instruction. In: *Proceedings of Selected Research and Development Presentations at the 1996 National Convention of the Association for Educational Communications and Technology (AECT)*. Indianapolis, IN.

Ruhl, K. L. (1996). Does nature of student activity during lecture pauses affect notes and immediate recall of college students with learning disabilities? *Journal of Postsecondary Education and Disability, 12*, 16–27.

Ruhl, K. L., Hughes, C. A., & Gajar, A. H. (1990). Efficacy of the pause procedure for enhancing learning disabled and nondisabled college students' long- and short-term recall of facts presented through lecture. *Learning Disability Quarterly, 13*, 55–64.

Ruhl, K. L., & Suritsky, S. (1995). The pause procedure and/or an outline: Effect on immediate free recall and lecture notes taken by college students with learning disabilities. *Learning Disability Quarterly, 18*, 2–11.

Ryan, M.P. (2001). Conceptual models of lecture learning: Guiding metaphors and model-appropriate notetaking practices. *Reading Psychology, 22*(4), 289–312.

Scerbo, M. W, Warm, J. S., Dember, W. N., & Grasha, A. E (1992). The role of time and cuing in a college lecture. *Contemporary Educational Psychology, 17*, 312–328.

Stahl, N. A., King, J. R., & Henk, W. A. (1991). Enhancing students' notetaking through training and evaluation. *Journal of Reading, 34*, 614–622.

Suritsky, S. K., & Hughes, C. A. (199 1). Benefits of notetaking: Implications for secondary and postsecondary students with learning disabilities. *Learning Disabilities Quarterly, 14*, 7–18.

Titsworth, B. S. (2001). The effects of teacher immediacy, use of organizational lecture cues, and students' notetaking on cognitive learning. *Communication Education 50*, 283–297.

Titsworth, B.S. (2004). Students' notetaking: The effects of teacher immediacy and clarity. *Communication Education, 53*, pp. 305–320.

Titsworth, B. S., & Kiewra, K. A. (2004). Spoken organizational lecture cues and student notetaking as facilitators of student learning. *Contemporary Educational Psychology, 29*, 447–461.

Van Meter, D. E. (1994). Computer-aided lecturing. *Journal of Natural Resources and Life Sciences Education, 23*, 62–64.

*Williams, R. L. & Eggert, A. C. (2002). Notetaking in college classes: Student patterns and instructional strategies. *The Journal of General Education, 51*, 173–199.

Williams, R. L., & Worth, S. L. (2002). Thinking skills and work habits: Contributors to course performance. *Journal of General Education, 51*, 200–227.

Wirt, J., Choy, S., Gerald, D., Provasnik, S., Rooney, P., Watanabe, S., Tobin, R., & Glander, M. (2001). *The condition of education. Section 5: The content of postsecondary education.* Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2001072

Wittrock, M. C. (1990). Generative processes of comprehension. *Educational Psychologist, 24*, 345–378.

11 Test

Rona

Universit

Marily

Universit

David

University

This chapter exa
on test-wiseness
A section on imp
grate strategies o
apply them. Final

TEST PREPARA

Achievement on t
negotiating in adv
form acceptably o
receive financial a
to graduate and p
ability in educatio
demonstration of
remain employed i
for licensure, certi
test scores can aff
appears essential.
of every reading a
instructional activi

The research lite
taking a test can in
lege curriculum. St
of approaches. Mar
In this sample, near
second year, and 50
outs and transfers a
concerns. However,
supportive services
made available to st
showed that Chican
skills, improved whe
through a self-moni