Effects of Note-Taking Format and Study Technique on Recall and Relational Performance

KENNETH A. KIEWRA
University of Nebraska, Lincoln

STEPHEN L. BENTON
Kansas State University

SUNG-IL KIM and NANCY RISCH
University of Nebraska, Lincoln

AND

MARIBETH CHRISTENSEN
Rexburg College

Two experiments investigated how different note-taking formats influenced student note taking. Experiment 1 investigated how different note-taking formats in combination with review activities affect recall and relational learning. During a 19-min lecture, participants either took notes in their conventional manner, on an outline framework, or on a matrix framework. Following the lecture, approximately half of the participants in each note-taking group prepared for performance tests by using their notes to write a comparative essay about the lecture topics. The others reviewed notes in their standard manner. Results indicated that essay writing was less effective than standard review practices for relational learning and that note-taking on an outline increased test performance beyond other note formats. Performance differences might have resulted from quantitative differences in note-taking favoring outline note-takers. Experiment 2 reexamined whether various note-taking formats influence student note taking. Students recorded lecture notes on various outline or matrix frameworks or without aid in their conventional manner. It was reconfirmed that a "flexible" outline framework, whose ordering of subtopics correspond to their order of lecture presentation, produces more note taking than a "collapsed" matrix framework presenting fewer subtopics to guide note taking. © 1995 Academic Press, Inc.

Beginning with DiVesta and Gray's (1972) seminal work on note taking, investigators have divided note taking into its process and product functions to determine whether the activities of recording notes (the process function) and reviewing notes (the product function) are effective independently. Although research (see Kiewra, 1985) has generally confirmed that note taking's process function is limited and its product function is

Address reprint requests to Kenneth Kiewra, Department of Educational Psychology, University of Nebraska at Lincoln, 1313 Seaton Hall, Lincoln, NE 68588-0641.

0361-476X/95 $6.00
Copyright © 1995 by Academic Press, Inc.
All rights of reproduction in any form reserved.
robust, students commonly engage in both activities and do so using a variety of techniques. Unfortunately, researchers have rarely designed experiments that manipulate either note-taking or study activities (see Kiewra, 1985), let alone both in the same study. Experiment 1 examined three note-taking formats and two study techniques to determine which note-taking formats and study techniques are independently or concommitantly effective. Experiment 2 reexamined the note-taking formats used in Experiment 1 along with several derivations.

NOTE-TAKING FORMATS

The three note-taking formats involved note taking in a conventional format, note taking on an outline framework, and note taking on a matrix framework. These three formats can be distinguished along two important dimensions—a quantitative dimension based on their potential completeness and a qualitative dimension based on their potential to encourage the formation of internal connections in memory (Mayer, 1984). With respect to completeness, previous research using these formats indicates that outline and matrix notes, once completed, contain more ideas than conventional notes (e.g., Kiewra, DuBois, Christian, McShane, Meyerhofer, & Roskelley, 1991). Students left to their own devices are terribly incomplete note takers recording only about 30% of lecture idea units for future reference. Outline and matrix frameworks normally boost note taking to a level at which approximately 40% of the lecture idea units are recorded (Kiewra et al., 1991). Previous research has maintained that the number of idea units in notes is positively related to test performance (e.g., Kiewra & Benton, 1988).

From a qualitative perspective, these three formats have the potential to vary considerably along a continuum for building internal connections (Mayer, 1984). According to Mayer, test performance is facilitated when ideas are well connected or organized in memory. Conventional notes generally do not foster internal connections because they lack local and global coherence. They lack local coherence when recorded facts are not associated with their immediate topics or subtopics. For example, given the lecture statement "The motivation for expressive creativity is to create a momentary flash of brilliance," the conventional note taker generally writes the statement "create momentary flash of brilliance" without reference to the topic of expressive creativity or the subtopic of motivation. Conventional notes lack global coherence because they rarely acknowledge unspecified relations between concepts. For instance, the conventional note taker is unlikely to note the relationship between the times necessary to become expressively and emergently creative if these two facts are presented separately in the lecture without reference to each other.
Outline and matrix formats better foster internal connections. Outline notes foster internal connections two ways. One, their outline structure makes superordinate—subordinate relations within topics apparent which facilitates local coherence. The outline notes in this study, for example, listed and indented subtopics (such as "motivation" and "time necessary to become creative") beneath topics. Two, because topics and subtopics are provided, all recorded lecture points become connected to at least a topic and subtopic thereby forming at least two retrieval pathways to any recorded idea, assisting in global coherence. Matrix notes should particularly help students build internal connections. Similar to outline notes, they accent superordinate—subordinate relations and tie recorded ideas to topic and subtopic. In addition, matrix notes emphasize across-topic relations. A student can read across the matrix and readily examine all the information about a subtopic by following that subtopic across the major topics. For example, information about the time necessary to become creative appears along the same matrix row for each of the five types of creativity even though these facts were presented independently throughout the lecture. Outline and conventional notes physically separate across-topic ideas and obscure the global relations among them. The "localization" of related ideas is a prime reason that two-dimensional representations, such as the matrix, are considered more computationally efficient (Larkin & Simon, 1987) than linear representations such as outlines and conventional notes. Information across topics can be drawn more easily and quickly from a matrix than a linear representation.

There is empirical evidence, from studies employing instructional materials similar to those used in the present study, supporting matrix notes over conventional notes (Kiewra et al., 1991) and matrix and outline notes over a written lecture transcript (Kiewra, DuBois, Christian, & McShane, 1988) for factual recall. In addition, matrix notes produced higher relational performance than a written lecture transcript (Kiewra et al., 1988).

STUDY TECHNIQUES

It is resoundingly clear that reviewing notes produces higher achievement than not reviewing notes (e.g., Kiewra, 1985; Kiewra et al., 1988). The note-taking literature is essentially silent, however, with respect to the performance effects of actually manipulating study behaviors. One study (Kiewra, 1983) that did manipulate review activities found that reorganizing notes during review produced higher free recall performance but lower cued recall performance than standard review.

In Experiment 1, we introduced the study technique of essay writing and compared its effectiveness to standard review practices. Much has been written about how the writing process facilitates thinking, promotes relational understanding, and improves recall (see, for example, Langer,
1986; Marshall, 1987; Van Nostrand, 1979). More specifically, research investigating note taking and writing indicates that the form of notes used in preparation for writing influences organizational aspects of writing. Students using matrix notes produced essays that were more comparative (Robinson & Kiewra, 1994), cohesive (Benton, Kiewra, Whitfall, & Dennis, 1993; Robinson & Kiewra, 1994) and coherent (Benton et al., 1993) than students using outline notes. The additive performance effects of producing notes and writing from them, however, are not known.

**EXPERIMENT 1**

Experiment 1 investigated how different note-taking formats and review activities affected recall and relational performance. Predictions for Experiment 1 were framed by the quantitative and qualitative dimensions mentioned previously. With respect to note-taking formats, we expected that matrix and outline notes would produce higher achievement than conventional notes because of the former's relative completeness and potential for forming internal connections compared to conventional notes. The matrix group was also expected to outperform the outline group on a relational test requiring that across-topic relations be drawn. Only the two-dimensional matrix helps form global connections across topics by positioning that information along the same row. In terms of study techniques, we expected that writing a comparative essay would bolster relational performance more than standard review because writing aids in building internal connections. Having organized the information into an essay, writers should also store information economically in memory and develop multiple retrieval pathways to aid recall beyond that of standard reviewers. The combination of matrix note taking and writing was expected to produce the best overall performance particularly with respect to relational learning. As mentioned previously the matrix format and the writing technique both foster internal connections.

**Method**

*Subjects and design.* Fifty-four undergraduate volunteers were randomly assigned to one cell of a 3 x 2 design, with the first factor being note-taking format (conventional, outline, matrix) and the second factor being study technique (essay, review). The number of volunteers assigned to each group appears in Table 1.

*Materials and apparatus.* Materials included a videotaped lecture, a television monitor, materials for note taking, the essay study task, and performance tests. The 19-min videotaped lecture about types of creativity contained 1881 words and was delivered at a rate of approximately 100 words per min on a 19-inch color television monitor. The lecture contained 121 idea units.

The conventional note takers received four sheets of lined paper. The outline framework and matrix framework were similar to those used previously (Kiewra et al., 1991). Modifications were made to simplify and increase note taking.

The outline framework was printed over four pages. It listed each of the five types of
creativity (e.g., expressive, adaptive) with common subtopics subsumed beneath each topic. Spaces were provided between subtopics for note taking. The order of subtopics varied across topics corresponding with their presentation order in the lecture. This flexible outline differed from the fixed version used by Kiewra et al. (1991) where the common subtopics always appeared in the same order for each type of creativity.

The matrix framework appeared on a single, oversized (38 × 20 cm) sheet of paper. Along the horizontal axis, the five types of creativity were named; along the vertical axis four common categories were listed (characteristics, time, motivation, and myths). Some of the category headings listed subcategories beneath them. Lines, however, divided the matrix into 20 cells based upon its five-topic by four-category configuration. Each cell provided space for notes germane to topic and category. This collapsed matrix differed somewhat from the full matrix (Kiewra et al., 1991) that included five topics, nine common categories, and 45 cells for note taking.

Modifications to the outline and matrix frameworks were made to aid note taking. The more flexible outline eliminated the need to skim and locate subheadings for each topic when determining where to note an idea. The subtopics’ changing order followed their varied order throughout the lecture. The collapsed matrix made locating the appropriate cell for note taking easier because only four subcategories were considered rather than nine.

The essay study task asked participants to compare and contrast the five types of creativity. Instructions indicated that essays would be scored for content and organization.

Two different performance tests were administered. The 10-item relational test required 20 responses. Each item asked students to name the two types of creativity that shared a common characteristic. The free-recall test asked students to recall whatever information they could about the five types of creativity that were named. The maximum number of recall ideas was 121.

Procedure. All 54 participants assembled in a large classroom and were randomly given experimental packets with instructions that defined and distinguished their group affiliation. Written general instructions informed all participants that they would view a 19-min videotaped lecture about creativity, review notes following the lecture, be tested immediately thereafter, and return next week for additional (but unspecified) activities. Instructions then specified whether acquisition activities would include conventional note taking, note taking on an outline, or note taking on a matrix framework. Participants were not, however, informed about their particular study technique until after the lecture so as not to affect note taking.

After instructions were read, the lecture was played and participants took notes as directed. Following the lecture, approximately half of the subjects in each acquisition group (as designated by packet code letters) were asked to prepare for the performance tests by using their notes to complete the essay task. The others (also designated by packet code) were asked to study their notes in preparation for performance tests. All participants were told that they had 25 min to complete their study activities.

Following the study period, participants returned all study materials to the folders and were administered the relational test. Following testing, participants were reminded that they had to return next week to complete the experiment. One week later, returning participants took the free-recall test.

Results

Test performance. To determine the effects of note-taking format (conventional, outline, matrix) relative to study technique (essay, review), separate 3 × 2 ANOVAs were conducted on relational and delayed-recall scores for all 54 subjects. We used the Fisher LSD to test observed
differences among note-taking formats. A significance level of $p < 0.5$ was used in all analyses. The means and standard deviations appear in Table 1.

The ANOVA for relational learning indicated a significant main effect for study technique, $F(1, 48) = 6.95$, $MS_e = 7.99$. Contrary to our predictions, those who reviewed notes (71% correct) outperformed those who wrote an essay (61% correct). The main effect of note-taking format was also significant, $F(2, 48) = 3.55$, $MS_e = 7.99$. Outline note takers outperformed conventional note takers as seen in the left column of Table 1. This finding only partially confirmed our predictions. We had expected outline note takers and particularly matrix note takers to outperform conventional note takers. The note-taking by study technique interaction was not significant.

The ANOVA for delayed recall also indicated a main effect for note-taking format, $F(2, 48) = 4.09$, $MS_e = 46.85$. Outline note takers recalled more ideas than conventional or matrix note takers as shown in the right column of Table 1. Again, this finding only partially confirmed our prediction. We had expected the matrix note takers to also recall more ideas than conventional note takers. Neither the predicted main effect for study technique, favoring essay writers over standard reviewers, nor the two-way interaction was significant.

Although the two-way interaction for delayed recall was not confirmed statistically, it appears that the interaction is of practical significance. The combination of outline note taking and essay writing appears more effective than the combination of outline note taking and review as seen in

<table>
<thead>
<tr>
<th></th>
<th>Performance tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relational</td>
</tr>
<tr>
<td>Essay ($n = 26$)</td>
<td>12.24 (.47)</td>
</tr>
<tr>
<td>Conventional ($n = 10$)</td>
<td>10.20 (.87)</td>
</tr>
<tr>
<td>Outline ($n = 8$)</td>
<td>14.15 (.97)</td>
</tr>
<tr>
<td>Matrix ($n = 8$)</td>
<td>12.63 (.97)</td>
</tr>
<tr>
<td>Review ($n = 28$)</td>
<td>14.16 (.45)</td>
</tr>
<tr>
<td>Conventional ($n = 9$)</td>
<td>14.22 (.92)</td>
</tr>
<tr>
<td>Outline ($n = 10$)</td>
<td>15.20 (.87)</td>
</tr>
<tr>
<td>Matrix ($n = 9$)</td>
<td>13.44 (.92)</td>
</tr>
<tr>
<td>Both Groups ($n = 54$)</td>
<td>12.21 (.63)</td>
</tr>
<tr>
<td>Conventional ($n = 19$)</td>
<td>14.66 (.63)</td>
</tr>
<tr>
<td>Outline ($n = 18$)</td>
<td>13.04 (.67)</td>
</tr>
<tr>
<td>Matrix ($n = 17$)</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. Among reviewers, outline note takers performed about .9 standard deviations above conventional and matrix note takers. In contrast, among essay writers, the outline note takers performed about 4.4 standard deviations above conventional and matrix note takers. This compelling contrast suggests that what is surely a practically significant interaction was not confirmed by inferential statistics due to small sample size.

Note-taking performance. All notes were scored for the total number of idea units (from a possible 121) and efficiency rating. This last measure is an assessment of the average number of words used to express an idea (Howe, 1970). To determine the effects of the three note-taking formats on note-taking behaviors, separate one-way ANOVAs were conducted on scores for both note-taking measures. Study technique did not enter into the analysis because this variable was introduced after notes were recorded. We used the Fisher LSD to test observed differences among note-taking formats. A significance level of $p < .05$ was used in all analyses.

The ANOVA for ideas was significant, $F(2, 51) = 4.14, MS_e = 125.91$. Fisher LSD tests indicated that outline note takers recorded more ideas ($M = 60.00$) than either conventional ($M = 51.37$) or matrix ($M = 50.06$) note takers. In a more general sense, these data indicate that the percentage of noted ideas ranged from 41 to 50% for the three groups.

The ANOVA for efficiency was also significant, $F(2, 51) = 4.09, MS_e = .56$. Fisher LSD tests indicated that both outline note takers ($M = 4.23$) and matrix note takers ($M = 4.12$) recorded more efficient notes (using fewer words to express an idea unit) than conventional note takers ($M = 4.78$). This was probably the result of outline and matrix formats reducing the need to record already provided headings and subheadings.

Essay-writing performance. All essays were scored for the number of lecture idea units to measure elaboration. Elaborate essays are one indication of topic knowledge stored in memory or externally in notes (Benton et al., 1993). We measured essay organization in two ways. First, organizational style was assessed by rating essays on a scale from zero to two based upon the degree to which they illustrate a linear topic-by-topic style of writing (scored as 0) versus a comparative across-topic style (scored as 2). Appendix A provides examples of essays that received organizational scores of "0" and "2." Next, the number of comparative (and contrastive) statements were tallied (Haliaday & Hasan, 1976). This measure assesses the degree to which facts are presented discretely versus jointly. Essays organized in an integrative fashion (using an across-topic style and relating independent facts) indicate greater maturity in writing (Bereiter & Scardamalia, 1987) and increased connections among ideas in memory.

To determine the effects of the note-taking formats on essay perfor-
mance, separate one-way ANOVAs were conducted on elaboration (number of ideas) and comparative statements. A Kruskal-Wallis ANOVA was conducted on organizational style. The significance level was set at $p < .05$ for all analyses. The ANOVA for elaboration was not significant, $F(2, 22) = 2.94, MS_e = 115.18$. The means, however, appear descriptively different. Outline note takers included more lecture ideas in their essays ($M = 42$) than conventional ($M = 35$) or matrix ($M = 29$) note takers. This pattern follows that found for lecture ideas appearing in notes.

The ANOVA for comparative statements was not significant, $F(2, 22) = .69, MS_e = 9.52$. This means that the note-taking groups wrote a similar number of comparative statements in their essays.

The Kruskal–Wallis ANOVA revealed that organizational style was significant, $KW(2, N = 25) = 6.82$. A multiple-comparison procedure indicated that outline and matrix note takers organized essays in an across-topic fashion more than conventional note takers.

The relationship between note taking, test performance, and study technique. The note-taking by performance correlation matrix presented in Table 2 indicates that the number of ideas in notes among all note takers was positively correlated with each of the performance test scores (as indicated beneath the column headings “both”). These findings were consistent with several other studies indicating that more extensive note taking is positively related to test performance (e.g., Kiewra & Benton, 1988). Table 2 also indicates that note-taking efficiency among all note takers was significantly and positively related to scores on the relational tests (as again indicated beneath the column heading “both”). This means that as notes became more efficient, relational performance scores increased as did recall scores to a milder degree. These data were also consistent with previous research (e.g., Howe, 1970).

Although separate note-taking by performance correlation matrices for each of the three note-taking formats did not show any practical deviation from the overall correlational analysis, such was not the case with respect

<table>
<thead>
<tr>
<th>Note-taking behavior</th>
<th>Performance tests</th>
<th>Relational</th>
<th>Recall</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Essay</td>
<td>Review</td>
<td>Both</td>
<td>Essay</td>
</tr>
<tr>
<td>Number of ideas</td>
<td>.43*</td>
<td>.27</td>
<td>.35*</td>
<td>.69*</td>
</tr>
<tr>
<td>Efficiency rating</td>
<td>.54*</td>
<td>.20</td>
<td>.36*</td>
<td>.36*</td>
</tr>
</tbody>
</table>

* $p < .05$. 

TABLE 2
Note-Taking Behavior by Performance Pooled Correlation Matrix for the Study Technique Groups (Essay and Review) and Both Groups in Experiment 1
to the study-technique conditions. Further inspection of Table 2 indicates that the relationships between note-taking behaviors and performance measures were significant in each case for the essay writing group but nonsignificant for the standard review group. In the case of "number of ideas" and "recall," the correlation involving essay writing is significantly higher than the correlation involving standard review, $z = 1.90, p < .05$ (one-tailed test). Correlation differences suggest that the intervening study technique treatments differentially influenced the relationship between recorded notes and performance. Apparently, the writing of an essay somehow more strongly tied the content of notes to subsequent test performance.

Discussion

Our predictions for Experiment 1 were not confirmed. With respect to note taking, we predicted that matrix and outline note takers would outperform conventional note takers and that matrix note takers would outperform outline note takers on the relational test. In actuality, outline note takers performed best.

Outline note takers outperformed conventional note takers on the relational test, and recalled more ideas than conventional and matrix note takers on the delayed-recall test. In addition, among participants who wrote essays, outline note takers included descriptively more lecture ideas in their essays than did conventional and matrix note takers. We offer both a quantitative and qualitative interpretation for these findings. From a quantitative perspective, outline note takers had access to more information during review activities than either conventional or matrix note takers who recorded significantly fewer notes. Results from this study and previous studies (e.g., Kiewra & Benton, 1988), in fact, indicate that the number of ideas in notes is positively related to test performance.

From a qualitative perspective, the advantage for outline notes may be attributed to their fostering internal connections among ideas. According to Mayer (1984), recall and relational performance are facilitated when ideas are well connected or organized in memory. Theoretically, the interconnection of ideas aids recall because recalling one idea can cue the recall of associated notions. Relational performance is facilitated because such tasks depend upon the learner identifying patterns and understanding relationships both within and across categories of information. The outline notes and the matrix notes should foster internal connections. Both permit learners to perceive readily information within and across categories.

In this experiment, matrix note taking did not have the performance
effects predicted from internal-connections theory and previous findings favoring matrix notes for relational learning (Kiewra et al., 1988), recall (Kiewra et al., 1991) and writing (Benton et al., 1993) relative to conventional or outline notes. It could be that matrix note takers made comparable but somewhat fewer connections than did outline note takers, given that matrix note takers recorded fewer lecture ideas in notes and essays than outline note takers. In fact, organizational writing assessments showed no differences between outline and matrix note takers.

In short, results from this experiment cannot confirm that outline notes were qualitatively superior to matrix notes given that outline and matrix notes lacked quantitative equivalence. According to Larkin and Simon (1987), judgments cannot be made regarding computational (qualitative) equivalence unless informational (quantitative) equivalence is maintained. Observed performance differences in this study are more naturally traced to the outline’s quantitative advantages.

With respect to study technique, results showed an advantage for review over essay writing on the relational test. At first glance, these data do not fit our prediction. We thought that essay writing would especially facilitate relational performance, because the essay task required a synthesis of ideas.

A closer look at the data, however, shows that the relatively low performance among essay writers was resident among those writers who did not record outline notes (see Table 1). Outline note takers who wrote essays actually performed as well or better than reviewers across the performance tests and produced the descriptively highest score on the recall test. The success of this group can be explained by the relative completeness of their notes reexpressed in relatively elaborate essays. These test, note-taking, and essay data coupled with correlational data in Table 2, indicating that essay writing somehow strengthens the relationship between note taking and test performance, suggest that essay writing may prove effective if writing follows from relatively complete and organized notes. At this point, essay writing should not be abandoned as a possible study technique.

EXPERIMENT 2

The results of Experiment 1 were at odds with those of a previous study (Kiewra et al., 1991). In the previous study the matrix notes produced higher recall than conventional notes and somewhat higher relational performance and recall than outline notes. In contrast, the outline notes proved most effective in Experiment 1. Outline note taking produced higher recall than conventional or matrix note taking, superior relational performance compared to conventional note taking, and somewhat more elaborate essays than the other formats.
Achievement differences between the two studies perhaps resulted from differences in note taking summarized in rows one and two in Table 3. The top row shows that in the previous study (Kiewra et al., 1991) matrix and outline formats produced comparable amounts of note taking but more than the conventional format. The second row shows that in Experiment 1 the outline format produced more note taking than conventional or matrix formats. There is evidence from Experiment 1 and previous studies (e.g., Kiewra & Benton, 1988) that the number of lecture points in notes is positively related to achievement.

Note-taking differences might have occurred because of modifications made to outline and matrix frameworks in Experiment 1 intended to bolster and simplify note taking. Remember that the fixed outline used previously (Kiewra et al., 1991) was made flexible in Experiment 1. The flexible outline’s subtopic ordering was consistent with the lecture’s varied presentation order. The modified matrix in Experiment 1 contained 20 cells for note taking. This collapsed matrix is contrasted by the full 45 cell matrix used previously (Kiewra et al., 1991). The note-taking data presented in rows 1 and 2 in Table 3 indicate that Experiment 1 modifications enhanced the outline but hindered the matrix as a note-taking format.

Experiment 2 reexamined the previous and modified note-taking formats to confirm their effect on note completeness. In addition, conventional notes and two new hybrid matrices were examined for completeness. The hybrid matrices blended characteristics from both the full and collapsed matrices.

**Method**

Ninety-one participants, drawn from a similar participant pool as those in Experiment 1, were randomly assigned to one of seven note-taking conditions described below. All par-

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>A Compilation of the Number of Idea Units Recorded in Notes Across a Previous Study (Kiewra et al., 1991), Experiment 1, and Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note-taking formats</td>
<td>Outline</td>
</tr>
<tr>
<td>Fixed</td>
<td>Flexible</td>
</tr>
<tr>
<td>Previous</td>
<td>56&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>Experiment 1</td>
<td>60&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>Experiment 2</td>
<td>52</td>
</tr>
</tbody>
</table>

*Note. Means with a-subscripts are significantly different from means with b-subscripts within the same row. Means with similar subscripts within the same row do not differ reliably.*
Participants were directed to record notes from the same 19-min videotaped lecture on creativity used in Experiment 1 and the previous study (Kiewra et al., 1991) in preparation for unspecified exams. Following the lecture, students' notes were collected, but contrary to announced procedures no exams were administered. Students were told to expect exams so that their motivation for note taking would be similar to students involved in Experiment 1 and previous research (Kiewra et al., 1991). The seven note-taking treatments are described below.

1. Conventional Notes ($n = 14$)—Students recorded notes in their natural way on four blank pages (as in Experiment 1 and Kiewra et al., 1991).

2. Fixed Outline ($n = 14$)—Subtopics were listed beneath each of five topics in a constant order despite their varied presentation order throughout the lecture (as in Kiewra et al., 1991).

3. Flexible Outline ($n = 12$)—Subtopics were listed beneath each of five topics in a changing order consistent with their varied presentation order throughout the lecture (as in Experiment 1).

4. Full Matrix ($n = 12$)—Five topics were crossed with nine subtopics creating a 45-cell matrix (as in Kiewra et al., 1991).

5. Collapsed Matrix ($n = 13$)—Five topics were crossed with four primary (but actually eight total) subtopics creating a 20-cell matrix (as in Experiment 1).

6. The $5 \times 9$ Hybrid ($n = 13$)—Five topics were crossed with the same nine subtopics presented in the full matrix. The nine subtopics though were presented as six general subtopics with two secondary subtopics below three of these. This new matrix contained 30 cells.

7. The $5 \times 6$ Hybrid ($n = 13$)—Five topics were crossed with the six general subtopics presented in the $5 \times 9$ Hybrid. Secondary subtopics were omitted. The new matrix contained 30 cells.

**Results and Discussion**

Notes were scored for the number of lecture points. A one-way ANOVA ($p < .05$) indicated that note-taking format produced differences in the number of lecture points recorded among the groups, $F(6, 84) = 2.41, \ MS_e = 162.35$. We explored all possible pair-wise comparisons using the Tukey HSD procedure ($p < .05$). It revealed that the flexible outline produced more note taking than the collapsed matrix. These means appear in Table 3's bottom row. No other comparisons proved reliable.

Results from Experiment 2 are consistent with those from Experiment 1 and previous research (Kiewra et al., 1991). First, the observed difference between the flexible outline and collapsed matrix replicates that finding from Experiment 1 shown in row 2 in Table 3. A second consistency is the comparable note-taking behaviors of the fixed outline and full matrix groups as seen in Table 3's top and bottom rows. In both Experiment 2 and the previous study, these formats produced nearly identical amounts of note taking. Last, notice that conventional note-taking techniques restricted note taking compared with the flexible outline or the full matrix. These comparisons demonstrate that effectively designed note-
taking devices boost note taking beyond conventional techniques. But what makes an effective design?

Flexible outlines work better than fixed outlines. Data from Table 3 indicate that the flexible outline produced modest but consistent note-taking increases compared with fixed outlines. We suspect that paralleling the outline's subtopic order with the lecture's changing subtopic order (a) reduced searching for the appropriate note-taking space and (b) cued what subtopic was next.

Different matrix frameworks also affected note taking differentially. It appears that the number of matrix cells, more than the number of matrix subtopics, influenced note taking. The full matrix, containing nine subtopics and 45 cells, produced somewhat greater note taking than the collapsed matrix, containing eight subtopics and 20 cells, in Experiment 2 and when informally comparing results across Experiment 1 and the previous study (Kiewra et al., 1991). Additional confirmation comes from Experiment 2 findings associated with the hybrid matrices that differed in subtopic number (nine or six) but not in number of cells. The 30-cell hybrid matrices produced note taking that ranged between the 20-cell collapsed matrix and the 45-cell full matrix ($M = 49$ for the $5 \times 6$ Hybrid and $M = 52$ for the $5 \times 9$ Hybrid). We believe that matrix note takers adopted a "something is adequate" approach. This means that so long as some information was noted within each matrix cell, note taking was considered adequate. It did not always matter that notes address a secondary subtopic for which no separate note-taking cell existed. The full matrix, containing the maximum 45 cells, therefore encouraged students to record relatively more notes.

**GENERAL DISCUSSION**

Previous research had not investigated how various note-taking formats work in combination with different review activities. We investigated three note-taking formats in combination with two review activities. It was expected that note-taking formats and review activities that organize and synthesize lecture ideas would prove beneficial. In particular, matrix note taking, because it organizes lecture ideas two dimensionally by topic and subtopic, and essay writing, because it encourages synthesis across lecture topics, were expected to produce the highest achievement. Instead, outline note taking proved better than conventional note taking and matrix note taking for delayed recall.

The outline's effectiveness was traced to its advantage over conventional and matrix notes which both contained fewer lecture ideas. The form of outlines and matrices, however, influence note-taking quantity. A flexible outline that adapts to a lecture's changing structure facilitates
note taking relative to a matrix that limits note-taking cues. A matrix providing ample cues or subtopics along its side margin, however, produces note taking comparable with a flexible outline.

Students' typical review activities also proved more effective than essay writing for relational learning but not delayed recall. Several lines of evidence, in fact, suggested that the combination of outline note taking and essay writing maximize delayed recall. Apparently the combination of producing complete and organized outline notes and generating a comparative essay from notes facilitates long-term retention of lecture ideas.

Based upon our findings, we encourage educators to maximize student note taking using flexible outline frameworks and perhaps matrix frameworks containing sufficient subtopic cues. Although we cannot yet advocate essay writing as a review technique, its use appears promising in combination with complete and organized notes. We encourage researchers to investigate essay writing as a review method further in combination with a relatively complete and organized representation of the lecture.

APPENDIX

Essay with Organization Score = 0

The first type of creativity is expressive, which can be characterized by the ability to generate rapid responses. This type of creativity gives the person a momentary flash of brilliance. An example of this could be a college professor answering questions from his/her class. The professor is able to answer any questions within a few seconds. Myths associated with this are that the person has overpracticed the responses or that the response is spontaneous.

The second type of creativity is adaptive which is distinguished by the ability to use past experience or knowledge to solve problems. The motivation usually includes maintaining the status quo. For example, a homemaker can plan or solve day-to-day problems as in planning menus or housecleaning. The myth involved is that flexibility is the key to problem solving and the person has overlearned effective problem solving.

Third, innovative creativity, is defined as the ability to alter or change a major process or product. A person that has a strong desire to make changes and improve is usually in this category. They are motivated by their dissatisfaction in things and their need for improvement. For example, an inventor is always trying new products for improvement or a writer who will alter their style. The myth connected with this type of creativity is that the creativity stems from originality.

Fourth, emergentive creativity is the person's ability to profoundly change beliefs or ideas. They attack basic assumptions and have strong faith in their own ideas. An example of this would be people who give rise
to revolutions, such as Darwin or Freud. They are motivated to be trend setters or followers. The idea that products or ideas rise above their times is a common myth.

Lastly, school-oriented creativity involves the generation of unskilled and rapid responses. School children prove to be an excellent example when they fingerpainted or doodle on paper. They seem to be motivated by personal satisfaction. Myths believed are that they relate this to real life creativity and that no skill is required.

Essay with Organization Score = 2

There are five types of creativity: expressive, adaptive, innovative, emergentive, and school-oriented creativity. There is not much similarity in the different characteristics of the types of creativity. The two most alike are innovative and emergentive. These people are inventors and are driven to make changes in the world. They are both motivated to change major processes, products and thoughts.

There are also many contrasts among the characteristics. Expressive creativity is a very rapid response, whereas innovative and emergentive are very predictable and take long periods of time, not at all rapid. Adaptive involves analyzing problems and planning solutions. It is very systematic and takes time to master. In contrast, expressive creativity is very rapid, and gives the appearance of being spontaneous.

The similarities in motivation among these five types are very few. The only two that are similar are innovative and emergentive. They both require motivation stemming from dissatisfaction with the way things are. There are several contrasts with regard to motivation. Expressive creativity is motivated by a momentary flash of brilliance. Adaptive stems from a desire to maintain the status quo. School-oriented creativity has no motivation at all. It has no meaningful thought process to it.

REFERENCES


