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ABSTRACT

The types and frequency of markings students made on multiple choice tests were studied as an indication of students' metacognitive test-taking strategies. Also studied was whether instruction in test-taking strategies affected students' fluency and flexibility of strategy use as demonstrated through the marks they made on tests. Participants were 90 undergraduates in 16 sections of a learning strategies course. Students were tested on three occasions in the semester. Answer indication and option elimination marks were most commonly made, with option elimination marks most commonly associated with high test scores before test-taking strategy instruction. After strategy instruction, and perhaps as a result of increasing the number of markings students made overall, none of the categories of markings were significantly correlated with high test scores. Following test-taking strategy instruction, both the fluency and the flexibility of types of markings increased, although flexibility decreased when students were tested several weeks after instruction. There was a difference in the pattern of markings of successful versus unsuccessful test takers. Option elimination, answer change, and selective item markings were evidently used by the student as metacognitive aids. (Contains 10 tables and 22 references.) (SLD)

THE EFFECTS OF TEST-TAKING STRATEGY INSTRUCTION ON THE PROCESSING OF TEST ITEMS

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Running Head: Test-Taking Strategies

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Introduction

Multiple choice tests are one of the most common ways we have of evaluating student achievement at the college level. Research on test-taking strategies suggests that cognitive strategies may be successfully instructed to and applied by college undergraduate students on multiple choice tests (Dolly & Williams, 1986). In studies comparing academically successful to academically unsuccessful students, it has been found that high performers demonstrate a greater knowledge of effective test-taking skills and use learning strategies that lead to a deep, rather than to a superficial level of encoding and (Bruch, Pearl & Giordano, 1986). Weinstein (1988) suggests that instruction of these strategies within a metacognitive framework will promote transfer and application of these strategies across different academic situations. The length of time spent on instructing test-taking strategies also seems to be of importance: in a 1985 meta-analysis of 24 programs which taught test-taking skills to elementary and secondary school students, Samson found that training programs which lasted five weeks or longer produced significantly greater results than did shorter programs. In addition, Dolly and Williams (1986) found that, while testwiseness strategies may be taught, these strategies have limited generalizability to other exams. Their results show that these strategies are effective only when applied to items which are susceptible to testwiseness strategies.

Testwiseness

Previously, research on students' responses to multiple choice questions has come from the field of item response theory and from the analysis of individual test items. These techniques allow us to evaluate the quality and difficulty of items on exams along with giving us a glimpse into what item alternatives or concepts are most difficult for students. Testwiseness or strategic test-taking encompasses a slightly tangential, if related fields.

The idea of "testwiseness" was originally discussed by Thorndike (1951) and thought to be a variable which could possibly affect test reliability. Thorndike considered testwiseness to be a general and lasting cognitive factor in that the manner in which an individual responded to tests affected her scores across content areas. Given this view, testwiseness can be seen as part of any test score. However, Thorndike considered testwiseness to be part of the *error* in an individual's test score. Currently, researchers in the area of testwiseness have differing views. Scruggs & Lifson (1985) argue that test-wiseness is a large source of variance that is commonly found in tests and that it is not related to general intelligence, stating "the influence of test-wiseness has been greatly overestimated." Conversely, Green & Steward (1984) see test wiseness as simply an artifact of one general cognitive ability. They view it as a highly developed reasoning ability which is combined with both general and specific experience. Other investigators (Dolly & Williams, 1986; Evans,1984) believe that test-wiseness is not a general ability, but that it is cue specific given the nature of individual items.

Weinstein (1988) uses the term "test-taking strategies" to refer to the concept of test wiseness. As in the definition of test wiseness, an individual who employs test-taking strategies is expected to get a higher score on a test than an equally able individual who does not employ test-taking strategies. Farr, Pritchard & Smitten (1990) have found that students approach a test in three different ways; by employing reading strategies, by using an overall approach to the test task and by using test-taking strategies. However, few investigations indicate what kind of strategies are significantly related to increased test performance. Research from the field of reading (Anderson & Armbruster, 1984; Nist & Kirby, 1989) suggests that underlining and annotations may facilitate comprehension while reading test questions. Other investigators have found that changing answers (Hanna, 1989); a low level of anxiety (Covington & Omelich, 1987); and using an outline before studying (Mannes & Kintsch, 1987); may aid test performance. In a study of the type of test markings that college

students made on a multiple choice exam, Kim and Goetz (1991) found that item elimination marks are significantly correlated with high test scores. In general, results from the metacognitive literature suggests that learners that proactively process information, such as test items, are more likely to understand and recall what they learn.

Metacognition and Strategy Use

Strategic learning, higher-order metacognitive processes, and executive mechanisms are critical components in successful learning and transfer (Borkowski & Kurtz, 1987; Garner & Alexander, 1989). However, superordinate control processes have been interpreted in different manners by different authors. Flavell (1979) defines metacognition as "knowledge that takes as its object or regulates any aspect of any cognitive endeavor." In actuality, there are two parts to this definition; knowledge about one's own cognition that is statable or accessible to the individual and knowledge about the regulation and control of this knowledge (Campione, 1987). A further definition of these terms and how these components might function together in processing test items is necessary.

Executive Control

Executive control is the regulation and control of one's knowledge. It involves high-level management of learning. Self-regulatory activities are engaged during an attempt to learn or solve a problem and involve planning, selecting, implementing, monitoring, modifying and evaluating (Weinstein, Meyer & Stone, 1991). Research in the late 1970's and early 1980's began to include an executive control component, with the result that transfer of the trained strategies was enhanced. At this point, researchers involved in courses on learning-to-learn began incorporating this element of metacognition into their work (Campione, 1987).

Awareness of cognition

Metacognition includes the component of awareness of one's cognition and cognitive resources. In the early 1980's the typical training study typically involve the students as active participants in the training process. Subjects were asked to use a sequence of steps in problem solving but were not informed why or under what circumstances such a strategy should be used. Such studies tended to produce limited transfer.

Strategies

Strategies are higher-level plans that help the learner to identify the specific skills needed for a learning task (Pressley, Borkowski & O'Sullivan, 1984; Weinstein & Underwood, 1985). A large number of studies have attempted to instruct individuals in a specific strategy and then to measure transfer on a novel task. The results of these studies have been that individuals could be taught to carry out strategies, which resulted in improvement in performance but they frequently abandoned the strategy when the experimenter ceased prompting its use; and then failed to apply the strategies to new problems where they would be appropriate. Strategy training has been supplemented with metacognitive training which include the awareness and executive control components discussed previously.

Metacognition and Test-taking

A student who is metacognitively aware monitors her comprehension. A major function of executive control is to aid when comprehension failure occurs. In the case of test-taking, the student must monitor the items she is answering, be aware of especially problematic items, monitor what knowledge she has which can be applied to an item, and which items she should skip and work on later. When a strategy is not successful, a different one must be selected in order to answer the item. This process of executive control, of modifying one's strategies, is dependent upon the fluency and flexibility of strategies which are employed. Weinstein (1988) describes fluency as the

amount of strategies which one possesses, while flexibility refers to the variety of strategies one possesses and can apply. She sees fluency in strategy use as aiding in the access of *related* portions of existing knowledge, while the flexibility of strategy use aids in accessing *different* portions of prior knowledge. Flexibility in strategy use seems to be the primary problem which most students have in learning and studying. For example, if a student has a comprehension problem while attempting to answer a difficult item, she might try rereading the item. If this does not help her, then she is likely to skip the item, rather than implementing another strategy. This might be an effective test-taking strategy initially, but eventually, if the student is to answer the item correctly, she must employ a successful strategy (rather than simply guessing) to answer an item correctly.

Test-taking Strategies and Test-markings

Kim and Goetz (1991) have investigated the types of markings which college students make on multiple choice tests. They argue that successful students might use more sophisticated test-taking strategies than do less successful students. In their study, they examined six types of test-markings which students made in response to multiple choice items; answer indications, option eliminations, key terms, selective item markings, elaborations and answer changes. They found that option elimination, key term, selective item, elaboration, and answer change markings were all significantly related to item difficulty. In each of these cases, the use of the strategy increased as the item difficulty increased. In addition, option elimination marks were found to be positively correlated with students' total test scores. Thus, item markings seem to be strategic in nature in that they adapt and are modified, given the requirements of the item.

Test markings might be an effective way to measure students' metacognitive test-taking strategies. The *frequency* of such markings can be utilized as a measure of the fluency of strategies which students employ to attempt to answer items correctly.

The variety of markings used can likewise be utilized as a measure of the flexibility of the strategies used on the items.

For this study the questions of interest are: What type of test markings are the most commonly used by students taking a multiple choice test? Are certain kinds of markings correlated with higher test scores? With correctly answering an item? With incorrectly answering an item? As an item becomes more difficult, does the student increase the fluency and flexibility of the strategies which she employs? In addition, does the instruction of test-taking strategies, within a course on metacognitive strategy use, affect the students' fluency and flexibility of strategy use?

Method

Subjects

397 undergraduate students enrolled in 16 sections of a learning strategies course at a major Southwestern university were given, as part of the requirements of the course, three tests over the course of the semester. Of those students, 90 were randomly selected to participate in this study. This student sample was stratified so that the students came from one of four different sections of the course, each with a different instructor. Instructors varied in the amount of previous teaching experience that they had; one instructor had previously taught the course for six semesters, one instructor had four semesters of experience, one had three semesters of experience and one had not previously taught the course.

Although the subjects came from sections taught by four different instructors, the exam was based on common course material and common texts. Of the subjects, 12 percent were seniors, 19 percent were juniors, 35 percent were sophomores and 34 percent were freshmen. Subjects from the four sections who did not take all three tests over the duration of the semester were dropped from the sample.

Materials

The first test was administered six weeks after the beginning of the spring semester. It contained 15 multiple choice questions and two short answer items. The test covered course material on cognitive learning theory and time management. It counted for 15% of the final course grade.

The second test was administered eleven weeks into the semester. It also contained 15 multiple choice questions and two short answer items, but also included a short essay. The test covered course material on cognitive learning theory, strategy use, reading comprehension, notetaking and test-taking. The test-taking unit included a 50 minute lecture on how to prepare for and take tests. Test-taking strategies which were presented included; test-preparation strategies, time-management strategies, test-taking strategies before a test, during and after a test. Strategies for use when taking a multiple-choice exam were explicitly taught using multiple-choice questions as models. Types of test-markings were not categorized or defined for students, but were modeled during instruction. Test #2 was administered two days after the students had received instruction on test-taking strategies. This second test counted for 20% of the total course grade.

The final test was administered 15 or 16 weeks after the beginning of the semester, at the end of the course. It contained 45 multiple-choice items. The students had received additional instruction on stress-management and on integration of the above material. The final test counted for 22% of the total course grade.

Procedure

Students were tested in the rooms in which they received their lectures and the test was administered by their regular instructor. They received scantrons, which were later machine scored, along with their test booklets. They were verbally instructed to bubble in the test answers on the scantron card, but were told that they could write or mark on the booklets as they wished. These instructions were also

written on the front of the test booklet. Both the scantrons and the test booklets were collected at the end of the testing period.

Test booklets were examined and the categories used by Kim and Goetz (1991) were used to code the markings of each item; 1) answer indication markings (ie., circling, checking, writing or otherwise indicating the response option to be marked on the answer sheet), 2) option elimination marks (ie., crossing or rubbing out response options), 3) key term marks (ie., circling, underlining or drawing a box around the key terms in the stems or options of the item), 4) selective item marks (ie., a mark such as a question mark, a star or a check beside a subset of items), 5) elaboration or annotation marks (ie., additional words, drawings or diagrams written to the side of an item), and 6) answer change marks (ie., erasing or crossing out of an answer indication mark). A seventh category was added, that of "other" to account for marks which did not fall into the above categories, or for marks that were judged ambiguous by the raters.

Items from Test #1 were used to calculate interjudge agreement on the coding of markings of the items. A total of 1080 items from 72 different subjects were coded by two judges. The codings from these two judges were then compared (see Table 1). The coding of the items had extremely high interjudge agreement, with a θ index of .99.

A total of 1350 items were examined and coded (90 subjects X 15 items) for both Tests #1 and #2. For Test #3, 4050 items were examined and coded (90 subjects X 45 items). Each item had the possibility of being coded as having no marks at all or having any combination of up to all of the seven types of markings. This data was analyzed as to the overall frequency of each type of markings and the frequency of markings for each item. Point biserial correlations were calculated in order to examine the relationship between the types of markings a student used on a given item and the total test score received by the student.

The scantron cards were used to calculate the students' total grade on the exam and to determine the class average and standard deviation for each exam (Test 1:

Mean=11.1 (74%), SD=1.8; Test 2: Mean=13.0 (86%), SD=1.5; Test 3: Mean= 33.05 (73%), SD=4.8). Items were additionally analyzed to determine the difficulty level and the discrimination level of each item. In order to control for the differences in the difficulty level of each test as a whole, four items were selected from each test. Using the previously mentioned measures, these four items were equated on their difficulty levels and discrimination levels and selected from each exam. For each exam, a very easy item (p=.94-.95, R(IT)=.24-.38); an easy item (p=.80-.83, R(IT)=.32-.44); a moderately difficult item (p=.62- .67, R(IT)=.40-.48); and a difficulty item (p=.43-.46, R(IT)=.41-.46) were selected. The types of markings from each of these items were totaled for each subject to give a measure of the flexibility of types of test markings used. Thus, each level of item difficulty had a total number of 90 observations (one per subject).

Results

The number of students marking their test increased over the course of the semester. In Test 1, 80 of the students marked their test; in Test 2, after test-taking strategy instruction, 84 marked their tests and in Test 3, 87 marked their tests. Overall, 92.9% of the subjects made some category of marking on their test across the three exams.

The number and percentage of items which exhibited one of the seven categories of test marks are shown in Tables 2-4. For each test, answer indication marks were the most common type of marked used, followed by option elimination marks. For the first two tests, elaboration marks were the most third common marking, while for the final, key term markings were the third most common type of markings. The key term markings, "other" markings and elaboration markings were the fourth most popular type of markings for Tests #1, #2 and #3, respectively, while the fifth most commonly used marks were "other" for both Tests #1. key term for Test #2, and selective item marks for Test #3. The sixth most popular marking was the selective item

marking for Tests #1 and #2, while for Test #3 it was the "other" category of marking. For all three tests the least common type of marking were answer change markings.

In Test #2, after test-taking strategy instruction, the mean occurrence of all types of markings increased (see Tables 2-4), with the exception of key term marks and elaboration marks. In Test #3, all types of markings, with the exception of elaboration marks were increased over the relative markings from Test #1. The mean occurrence of all types of markings continued to increase in Test #3 over those in Test #2, with the exception of answer indication and option elimination markings (the most frequent type of marking) and markings classified as "other." The frequency, or fluency, of test markings did increase from Test #1 to Test #3 over the semester, following test-taking strategy instruction.

Correlational analysis was used to determine which of the types of test markings were associated with overall high test scores. Frequency of test markings were summed across all 15 items in Tests #1 and #2 and across all 45 items in Test #3. Correlations between test scores and types of markings are shown in Tables #5, #6 and #7. For Test #1, only option elimination markings were significantly ($p \leq .05$) positively correlated with high test scores, while option elimination markings were negatively correlated with high test scores. This indicates that those with higher test scores tended to use option elimination test scores, while those scoring lower on the test tended to use answer indication markings.

On Test #2, after test-taking strategy instruction, none of the types of markings were positively correlated with higher test scores. This implies that both successful and unsuccessful students were using test-marking strategies previously used only by the successful test-takers. In test #3, five to six weeks after the test-taking strategy instruction, answer indication, option elimination, key term, and selective item marks were positively correlated with a high test score, while "other" marks were negatively correlated with high test marks. Taken together, these results suggest that option elimination marks tend to be associated with high test scores, in both those who are

testwise and those who are not testwise, but not immediately following test-taking strategy instruction.

Some of the categories of markings were correlated with the difficulty of the items (see Tables #5-7). In Test #1, key term, selective item, elaboration and answer change marks were associated with difficult items. In Test #2, selective item and answer change markings were also associated with difficult items, as were elimination markings. Difficult items on Test #3 were significantly correlated with the same types of markings as were those on Test #1: key term, selective item, elaboration and answer change markings. Thus, it seems that the frequency of selective item marking and answer changes are consistently associated with difficult items.

Also of interest, is if certain markings are correlated with correctly or incorrectly answering an item. In order to control for the difference in the difficulty level of each item, four items from each test were equated as described earlier. Phi correlations were calculated for each item to determine association between types of markings and correctness of the item. In Test #1, option elimination markings were positively correlated with answering all but the difficult items correctly. In Test #2, after test-taking strategy instruction, selective item and "other" marks were associated with correctly answering easy items, while answer identification markings were positively associated with answering difficult items correctly. In Test #3, depending on the difficulty level of the item, elaboration, option elimination, and answer change markings were associated with correctly answering an item. Again, option elimination markings seem to be fairly consistently associated with correctly answering items, except directly after test-taking strategy instruction.

Conversely, several types of markings were negative correlated with getting an item correct. In Test #1, answer indication markings were associated with incorrectly answering an easy, moderate or difficult item. In Test #2, answer changes were associated with incorrectly answering very easy or moderate items. In Test #3, answer indication marks were, as in Test #1, associated with incorrectly answering difficult

items. Answer indication marks seem to be consistently associated with answering an item incorrectly before test-taking strategy instruction.

Since the ordering of the types of markings, along with the mean number of occurrences of markings, seemed to change from test to test, further analysis was conducted to examine the changes in flexibility of markings from test to test.

As a measure of flexibility of marking strategies, the total number of types of markings for the four equated items from each test were analyzed using log-linear analysis. The category of "7 different types of markings", as suggested by Wickens (1989,p.120) was eliminated since none of the three tables contained data in this category. Goodness of fit was calculate for the null hypothesis of "no change over time" using a Markov chain analysis for each of the item difficulty levels. This allowed the change in the number of types of marking of each student to be analyzed across the three tests. In the case of a nonsignificant change in numbers of types of markings, a test of marginal homogeneity was run to determine if there was a significant change in the number of types of markings from Test #1 to Test #2.

For all item difficulty levels, the number of types of markings increased after test-taking strategy instruction from Test #1 to Test #2 (see Table #10). None of the types of item markings increased from Test #2 to Test #3, and, in some cases, the types of markings dropped. Overall, however, the number of types of marking increased over the semester in response to very easy items and moderate difficulty items. Types of markings did not significantly change over the three tests for easy and difficult items. These results suggest that flexibility of test-marking strategies increase immediately after test-taking strategy instruction, but do not continue to increase, and, in the case of easy and difficult items, drop back to their original level.

Discussion

In this study several questions were of interest. The first question was: what type of test markings are commonly used by students on a multiple-choice test? Results of this study concur with the findings of Kim and Goetz (1991) in that answer indication and option elimination marks are most common. Also in concordance with their findings, was that option elimination marks are most commonly associated with high test scores before test-taking strategy instruction. However, immediately after test-taking strategy, and perhaps as a result of increasing the number of markings that students make overall, none of the categories of markings were significantly correlated with high test scores. Several weeks after instruction, option elimination marks, along with four other categories of markings are significantly correlated with high test scores. Since the number of these categories of markings are increasing from test to test, we might hypothesize that some students have begun to use test marking strategies that differ from their less successful peers. Two reasons could explain this change: the additional instruction of the learning strategies course is helping students become more effective in their strategy usage, or, since the Test #3 was the last exam of the course, successful students tend to use different and more effective strategies.

Certain types of item markings are correlated with correctly answering an item. Before strategy instruction, option elimination, at least for the 3 easiest categories of items, is most effective. On Test #3 it is also an effective strategy for easy and moderate items. For items of moderate and difficult levels in Test #3, answer change strategies were associated with correctly answering an item. This suggests that a student's score will be raised only after test-taking strategy instruction couched within a learning strategies course: Answer change was negatively correlated with answering an item correctly before and immediately following test-taking strategy instruction.

Students take into account the difficulty level of an item when they make test markings. Answer change and selective item markings consistently are applied by

them. This implies that a student is likely to mark and item to return to later if it is difficult, and she is more likely to change the answer to the item. However, making answer changes does not appear to be helpful, unless the item is of a moderate or difficult level, and she has continued to receive instruction in a learning strategies course.

Does test-taking strategy instruction appear to affect the flexibility of student test-marking strategies? It appears from this analysis that there was a significant difference between the flexibility of test-taking strategies across the three exams. The flexibility of the types of markings that are made in response to a difficult item increase immediately after test-taking instruction. This flexibility, however, then decreases after several weeks have passed.

In summary, following test-taking strategy instruction, both the fluency and the flexibility of the types of markings increases. The flexibility of the types of markings decreased, however, when the students were tested several weeks after the instruction. This is a finding repeatedly manifested in research on strategy instruction. Near transfer and application of a strategy is common, far transfer is elusive. In addition, flexibility of strategies is an area in which students demonstrate particular deficiencies (Weinstein, 1988). It should be noted, however, that the fluency or frequency of the types of markings continued to increase across the three types of the tests. This finding suggests that, while the types of marking strategies did not increase, within the individual categories, markings did increased, even weeks after strategy instruction. Continued enrollment in a learning strategies course appears to affect test marking.

Test marking patterns are correlated with a number of factors and seem to be strategic in nature. There is a difference in the patterns of markings of successful versus unsuccessful test takers. These markings are affected and increased by test-taking strategy instruction. Several of the types of markings (option elimination, answer change, selective item) are implemented by the student to metacognitively aid

her in answering items of certain difficulty levels correctly. Finally, the instruction of test-taking strategies within a learning strategies course increases the frequency of these strategic markings.

Table 1: Log-linear test of Interjudge Agreement: Based on codings of responses of 72 students on 15 items (1080 items total) from Test #1.

		JUDGE #2						
		ANS IND	ELIM	KEY TERM	SELECT	ELAB	ANSCHNG	OTHER	MISSING
JUDGE #1	ANS IND	1004	5	1	0	0	0	2	6
	ELIM	6	1004	0	0	0	0	5	10
	KEY TERM	2	1	1004	0	0	0	0	0
	SELECT	0	0	0	1004	0	0	1	1
	ELAB	0	0	0	0	1004	1	2	6
	ANS CHNG	0	0	0	0	0	1004	1	0
	OTHER	2	1	0	0	1	1	1004	2
	MISSING	4	3	1	2	4	4	2	1004

The "missing category" refers to cases in which a category marked by one of the judges was not marked by the other judge.

Interjudge Agreement:

Data Source	Model	G^2
From Table #1	No AXB interaction	32706.4077
Table #1: Diagonal cells replaced with structural zeros	No AXB interaction	49.6501

$$\text{Index } \theta = \frac{G^2_1 - G^2_2}{G^2_1} = \frac{32706.4077 - 49.6501}{|\ 49.6501} = .99$$

The relative proportion of the structure of Table #1 that depends on actual agreements is 99 percent. Thus, 99 percent of the structure in Table #1 is due to the agreements of the judges.

Table 2: Categories of Markings and Percentages of Total Markings Ranked in Order of Frequency of use by Students on Test #1. 18

Category	Percentage
Answer Indication	55.0
Option Elimination	27.6
Elaboration	8.6
Key Term	6.1
Other	4.4
Selective Item	3.5
Answer Change	1.0

N= 1350 items

Table 3: Categories of Markings and Percentages of Total Markings Ranked in Order of the Frequency of Use by Students on Test #2.

Category	Percentage
Answer Indication	71.9
Option Elimination	43.0
Elaboration	5.9
Other	5.8
Key Term	5.2
Selective Item	4.7
Answer Change	2.0

N=1350 items

Table 4: Categories of Markings and Percentages of Total Markings Ranked in Order of the Frequency of Use by Students on Test #3.

Category	Percentage
Answer Indication	68.4
Option Elimination	40.8
Key Term	7.4
Elaboration	6.2
Selective Item	5.9
Other	5.3
Answer Change	2.6

N=1350

Table 5: Intercorrelations among the Seven Marking Categories, Total Test Score and Difficulty Level for Test #1

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / Number of Observations

	TOTSCORE	ANSIND	ELIM	KEYT	SELECT	ELAB	ANSCHNG	OTHER	DIFF
TOTSCORE	1.00000 0.0 1657	-0.09231* 0.0007 1350	0.06781* 0.0127 1350	0.02976 0.2745 1350	0.00515 0.8500 1350	-0.03314 0.2237 1350	-0.00681 0.8025 1350	0.00981 0.7188 1350	0.00000 1.0000 1350
ANSIND	-0.09231 0.0007 1350	1.00000 0.0 1350	0.22970 0.0001 1350	0.14916 0.0001 1350	0.08258 0.0024 1350	0.07035 0.0097 1350	0.08926 0.0010 1350	0.08427 0.0019 1350	-0.00939 0.7304 1350
ELIM	0.06781 0.0127 1350	0.22970 0.0001 1350	1.00000 0.0 1350	0.15496 0.0001 1350	0.12664 0.0001 1350	0.20067 0.0001 1350	-0.01004 0.7125 1350	0.07859 0.0039 1350	-0.00851 0.7547 1350
KEYT	0.02976 0.2745 1350	0.14916 0.0001 1350	0.15496 0.0001 1350	1.00000 0.0 1350	0.05321 0.0506 1350	0.20974 0.0001 1350	0.07019 0.0099 1350	0.14284 0.0001 1350	-0.11628 0.0001 1350
SELECT	0.00515 0.8500 1350	0.08258 0.0024 1350	0.12664 0.0001 1350	0.05321 0.0506 1350	1.00000 0.0 1350	0.12921 0.0001 1350	0.14679 0.0001 1350	0.01870 0.4925 1350	-0.12845 0.0001 1350
ELAB	-0.03314 0.2237 1350	0.07035 0.0097 1350	0.20067 0.0001 1350	0.20974 0.0001 1350	0.12921 0.0001 1350	1.00000 0.0 1350	0.07803 0.0041 1350	0.05081 0.0620 1350	-0.06327 0.0201 1350
ANSCHNG	-0.00681 0.8025 1350	0.08926 0.0010 1350	-0.01004 0.7125 1350	0.07019 0.0099 1350	0.14679 0.0001 1350	0.07803 0.0041 1350	1.00000 0.0 1350	-0.02108 0.4390 1350	-0.10564 0.0001 1350
OTHER	0.00981 0.7188 1350	0.08427 0.0019 1350	0.07859 0.0039 1350	0.14284 0.0001 1350	0.01870 0.4925 1350	0.05081 0.0620 1350	-0.02108 0.4390 1350	1.00000 0.0 1350	-0.00791 0.7716 1350
DIFF	0.00000 1.0000 1350	-0.00939 0.7304 1350	-0.00851 0.7547 1350	-0.11628* 0.0001 1350	-0.12845* 0.0001 1350	-0.06327* 0.0201 1350	-0.10564* 0.0001 1350	-0.00791 0.7716 1350	1.00000 0.0 1350

* $p \leq .05$

Table 6: Intercorrelations among the Seven Marking Categories, Total Test Score and Difficulty Level for Test #2

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / Number of Observations

	TOTSCORE	ANSIND	ELIM	KEYT	SELECT	ELAB	ANSCHNG	OTHER	DIFF
TOTSCORE	1.00000 0.0 1651	-0.01576 0.5630 1350	-0.05039 0.0642 1350	-0.00113 0.9668 1350	0.00272 0.9205 1350	0.03820 0.1607 1350	-0.00848 0.7555 1350	0.04831 0.0760 1350	0.00000 1.0000 1350
ANSIND	-0.01576 0.5630 1350	1.00000 0.0 1350	0.18924 0.0001 1350	0.06432 0.0181 1350	0.05405 0.0471 1350	0.11362 0.0001 1350	0.08925 0.0010 1350	0.11938 0.0001 1350	0.02525 0.3539 1350
ELIM	-0.05039 0.0642 1350	0.18924 0.0001 1350	1.00000 0.0 1350	0.14122 0.0001 1350	0.10917 0.0001 1350	0.14063 0.0001 1350	0.07909 0.0036 1350	0.15706 0.0001 1350	-0.06405 0.0186 1350
KEYT	-0.00113 0.9668 1350	0.06432 0.0181 1350	0.14122 0.0001 1350	1.00000 0.0 1350	0.08932 0.0010 1350	0.16942 0.0001 1350	-0.00955 0.7260 1350	0.01368 0.6155 1350	-0.02390 0.3803 1350
SELECT	0.00272 0.9205 1350	0.05405 0.0471 1350	0.10917 0.0001 1350	0.08932 0.0010 1350	1.00000 0.0 1350	0.19684 0.0001 1350	0.19221 0.0001 1350	0.04933 0.0700 1350	-0.18741 0.0001 1350
ELAB	0.03820 0.1607 1350	0.11362 0.0001 1350	0.14063 0.0001 1350	0.16942 0.0001 1350	0.19684 0.0001 1350	1.00000 0.0 1350	0.05455 0.0451 1350	0.01942 0.4760 1350	-0.00157 0.9539 1350
ANSCHNG	-0.00848 0.7555 1350	0.08925 0.0010 1350	0.07909 0.0036 1350	-0.00955 0.7260 1350	0.19221 0.0001 1350	0.05455 0.0451 1350	1.00000 0.0 1350	-0.03538 0.1939 1350	-0.08448 0.0019 1350
OTHER	0.04831 0.0760 1350	0.11938* 0.0001 1350	0.15706* 0.0001 1350	0.01368 0.6155 1350	0.04933 0.0700 1350	0.01942 0.4760 1350	-0.03538 0.1939 1350	1.00000 0.0 1350	0.01940 0.4764 1350
DIFF	0.00000 1.0000 1350	0.02525 0.3539 1350	-0.06405* 0.0186 1350	-0.02390 0.3803 1350	-0.18741* 0.0001 1350	-0.00157 0.9539 1350	-0.08448* 0.0019 1350	0.01940 0.4764 1350	1.00000 0.0 1350

* $p \leq .05$

Table 7: Intercorrelations among the Seven Marking Categories, Total Test Score and Difficulty Level for Test #3

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / Number of Observations

	ANSIND	ELIM	KEYT	SELECT	ELAB	ANSCHNG	OTHER	DIFF	TOTSCORE
ANSIND	1.00000 0.0 4095	0.21414 0.0001 4095	0.11977 0.0001 4095	0.08058 0.0001 4095	0.10113 0.0001 4095	0.09088 0.0001 4095	0.09142 0.0001 4095	-0.01749 0.2633 4095	0.10953 0.0002 1146
ELIM	0.21414 0.0001 4095	1.00000 0.0 4095	0.16978 0.0001 4095	0.14931 0.0001 4095	0.12340 0.0001 4095	0.09630 0.0001 4095	0.10312 0.0001 4095	0.00299 0.8483 4095	0.26773 0.0001 1146
KEYT	0.11977 0.0001 4095	0.16978 0.0001 4095	1.00000 0.0 4095	0.07995 0.0001 4095	0.22829 0.0001 4095	0.05380 0.0006 4095	0.11111 0.0001 4095	-0.04734 0.0024 4095	0.06080 0.0396 1146
SELECT	0.08058 0.0001 4095	0.14931 0.0001 4095	0.07995 0.0001 4095	1.00000 0.0 4095	0.16314 0.0001 4095	0.07032 0.0001 4095	0.06508 0.0001 4095	-0.09346 0.0001 4095	0.06321 0.0324 1146
ELAB	0.10113 0.0001 4095	0.12340 0.0001 4095	0.22829 0.0001 4095	0.16314 0.0001 4095	1.00000 0.0 4095	0.05982 0.0001 4095	0.07799 0.0001 4095	-0.08858 0.0001 4095	0.05370 0.0692 1146
ANSCHNG	0.09088 0.0001 4095	0.09630 0.0001 4095	0.05380 0.0006 4095	0.07032 0.0001 4095	0.05982 0.0001 4095	1.00000 0.0 4095	0.00226 0.8849 4095	-0.05388 0.0006 4095	0.04832 0.1021 1146
OTHER	0.09142 0.0001 4095	0.10312 0.0001 4095	0.11111 0.0001 4095	0.06508 0.0001 4095	0.07799 0.0001 4095	0.00226 0.8849 4095	1.00000 0.0 4095	-0.01530 0.3276 4095	-0.07444 0.0117 1146
DIFF	-0.01749 0.2633 4095	0.00299 0.8483 4095	-0.04734* 0.0024 4095	-0.09346* 0.0001 4095	-0.08858* 0.0001 4095	-0.05388* 0.0006 4095	-0.01530 0.3276 4095	1.00000 0.0 4095	-0.01168 0.6929 1146
TOTSCORE	0.10953* 0.0002 1146	0.26773* 0.0001 1146	0.06080* 0.0396 1146	0.06321* 0.0324 1146	0.05370 0.0692 1146	0.04832 0.1021 1146	-0.07444* 0.0117 1146	-0.01168 0.6929 1146	1.00000 0.0 1324

* $p \leq .05$

Table 8: Types of Markings Correlated with Correctly Answering an Item ($p \leq .05$, n=90) 22

Difficulty Level of Item	TEST #1	TEST #2	TEST #3
Very Easy	Option Elimination	None	Elaboration
Easy	Option Elimination	Selective item	Answer indication Option elimination Elaboration
Moderate	Option Elimination	None	Option elimination Selective item Answer change
Difficult	None	Answer identification	Option elimination Answer change

Table 9: Types of Markings Correlated with Incorrectly Answering an Item ($p \leq .05$, n=90)

Difficulty Level of Item	TEST #1	TEST #2	TEST #3
Very Easy	None	Elaboration Answer Change	None
Easy	Answer indication Elaboration Answer Change	None	None
Moderate	Answer indication	Answer change	Key term
Difficult	Answer indication	None	Answer indication

Table 10: Log-Linear Analysis of the Increase in Types of Test Markings made from Tests #1-#3 using Markov Chains*

Difficulty Level of Item	Marg. Homo. Tests #1-2	df	Increase?	Likelihood Tests #1-3	df	Increase?
Very easy	31.9758	10	Yes	48.1986	30	Yes
Easy	45.3453	10	Yes	25.3942	30	No
Moderate	14.3258	6	Yes	31.667	20	Yes
Difficult	21.3234	15	Yes	18.4518	42	No

n=90 Subjects per item type

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