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ABSTRACT

The potential reliability and construct and predictive validity of a 30-item Study Skills Questionnaire (SSQUES) was evaluated for its ability to: (1) predict student performance in a self-paced, individualized, or computer-managed instructional environment, and (2) identify students needing some type of study skills remediation. The study was conducted in the context of the Air Force Advanced Instructional System: subjects were male and female Air Force trainees in four computer-managed instruction courses during a nine-week period. Students evaluated their skills in four areas: reading comprehension, memorization, concentration management, and test taking. The questionnaire demonstrated substantial reliability and construct validity. Predictive validity results supported the power of the SSQUES to predict student achievement and to discriminate between students who would perform well versus poorly. (Author/GK)

# The Study Skills Questionnaire (SSQUES): Preliminary Validation of a Measure for Assessing Students' Perceived Areas of Weakness

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## Abstract

A 30-item Study Skills Questionnaire (SSQUES), designed to evaluate students' perceptions of their study skills in the areas of reading comprehension, memorization, test taking, and concentration management, was subjected to a preliminary reliability and validity study in the context of the Air Force Advanced Instructional System. For approximately nine weeks, students in four computer-managed instruction courses were assigned the SSQUES following their first course block. The questionnaire demonstrated substantial reliability and construct validity, and predictive validity results supported the power of this measure to predict student achievement and to discriminate between students who would perform well versus poorly.

Although student study skills appear to be logically related to academic performance and some studies confirm this relationship (e.g., Brown, 1964; Brown & Holtzman, 1966, 1967; Desiderato & Koskinen, 1969. Miller & Michael, 1972), other studies either find no relationship (e.g., Bodden, Osterhouse, & Gelso, 1972; Hartley, 1966; McCausland & Stewart, 1974) or find a relationship for only specific types of students (e.g., Wen & Liu, 1976). The question is raised, therefore, concerning the adequacy of existing study skills measures for predicting student performance in the instructional environment.

Existing instruments that are frequently used to measure student study skills are the Brown-Holtzman (1966) Survey of Study Habits and Attitudes (SSHA) and the Study Attitudes and Methods Survey (SAMS; Michael, Michael, & Zimmerman, 1972). These instruments were not only validated in conventional, group-paced instructional settings, but have been used almost exclusively in such environments (e.g., Greiner & Karoly, 1976; Jackson & Van Zoost, 1974; Light & Alexakos, 1970; Miller & Michael, 1972). A further question can be raised, then, about the usefulness of these existing study skills measures for predicting student performance in the expanding number of innovative instructional environments which are applying recent developments in instructional technology to the classroom. For example, open classrooms, ability tracking, and various forms of self-pacing and individualized, computer-based instructional approaches are becoming more and more prevalent.

One example of advanced computer-based instructional technology applied to large scale training is the Air Force Advanced Instructional System (AIS). The AIS is a large scale computer-based training system in which students

in one of four technical training specialties learn their respective course materials via self-paced, individualized, and computer-managed instruction. Within this system, students progress at a rate determined by their individual skills, abilities, and interests.

The self-paced environment within the AIS necessitates that students take responsibility for their own learning, and that they know how to study effectively. Poor or inadequate study skills, however, characterizes a large number of AIS students. Furthermore, until various forms of individualized instruction become common in our public school system, few students will know how to transition their passive learning behaviors to the active information processing strategies and skills required for self-directed learning. Thus, AIS instructor personnel have found that the diagnosis and remediation of student study skills deficiencies is both critical to successful course completion by students and critical to their own role as counselor and tutor of students in the AIS environment.

Given the AIS environment and the criticality of effective student study skills in that environment, along with the problems with existing study skills measures, a new instrument was developed in the context of the AIS. This instrument was developed for use by either instructor personnel or computer-based adaptive decision models in the identification and diagnosis of students in need of specific study skills remediation. This measure differs from other commonly used measures in its use of both (a) comparative self-ratings of perceived academic abilities and effective study skills relative to other students and (b) forced-choice descriptions of specific study skills and behaviors. As suggested by a number of

researchers (e.g., Bornstein, Hamilton, Miller, Quevillon & Spitzform, 1977; Centra, 1977; Goldfried & D'Zurilla, 1973; Mischel, 1968), comparative self-ratings can be a particularly valid and predictive method for assessing student characteristics and behaviors. Thus, it was hypothesized that using comparative self-ratings in conjunction with the students' description of their study habits and skills would result in a measure that would be predictive of (a) student performance on AIS course materials (times-to-complete, criterion test scores) and (b) those students in need of study skills remediation.

The present paper reports the results of preliminary reliability and validity data on this new instrument, the Student Study Skills Questionnaire (SSQUES). The context for the evaluation was the four technical training courses supported by the AIS.

## Method

Subjects. Subjects were male and female Air Force trainees enrolled in the Inventory Management (IM), Materiel Facilities (MF), Precision Measuring Equipment (PME), and Weapons Mechanic (WM) courses during the period from July 1978 through September 1978. During this evaluation period, the number of students available for reliability and validity analyses were 313 in the IM course, 92 in the MF course, 79 in the PME course, and 297 in the WM course. Students were excluded from analysis if they failed to have reliable data on both the predictor and criterion variables. Student ages ranged from 17 to 41 years (mean = 21.5 years).

Measures. The initial SSQUES was composed of 50 multiple choice items which asked students to evaluate their skills in each of four areas:

Reading Comprehension (READCM), Memorization (MEMORY), Concentration Management (CONMGT), and Test Taking (TSTTAK). There were 15 READCM items, 12 MEMORY and 12 CONMGT items, and 11 TSTTAK items. Following a preliminary small group tryout to assess the questionnaire's internal consistency, 20 of the original 50 items which consistently demonstrated low item remainder correlations with the total scale or appropriate subscales were dropped. The resulting 30-item SSQUES used in the reported reliability and validity analyses contained eight READCM items, seven MEMORY items, nine CONMGT items, and six TSTTAK items. A copy of the 30-item SSQUES and its subscales is shown in Table 1. Student directions, printed on the SSQUES were: "A number of statements which students have used to describe their study habits and skills are given below. Please read each statement carefully and then blacken the space on your answer sheet which best describes your study habits and skills. There are no right or wrong answers. Do not spend too much time on any one statement, but select the answer which best describes your study habits and skills. Notice that you are asked to describe your study skills in four basic areas (reading comprehension, memorization, test-taking, concentration management)."

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Insert Table 1 about here

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The criterion variables of interest in this study were times-to-complete and criterion test scores on selected blocks and lessons in the IM, MF, PME, and WM courses.

Procedure. The SSQUES was placed in each of the four AIS course hierarchies such that it was the first assignment students received after successfully completing the first block of their respective course. During this evaluation period of approximately nine weeks, reliability data for the SSQUES and its subscales were collected by the AIS software for subsequent analysis by the AIS Test Item Evaluation program. Similarly, validity data were automatically collected by the AIS software for subsequent analysis by the AIS Data Analysis System. This data analysis capability provided an interface with standard statistical packages.

## Results

Questionnaire Reliability Results. The means, standard deviations, and alpha reliability coefficients for the 30-item SSQUES and its four subscales are reported in Table 2 for all four AIS courses. The AIS Test Item Evaluation (TIE) program was used in the calculation of all reliability results.

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Insert Table 2 about here

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As Table 2 indicates, the alpha reliabilities of the SSQUES ranged from a low of .81 to a high of .95, indicating high internal consistencies for the total questionnaire across the four AIS courses. It should be noted that only in the WM course did the alpha reliability of the total scale drop below .90. The reliability data reported in Table 2 also indicate that (a) the alpha reliability of the READCM subscale ranged from a low of .58 to a high of .87; (b) the MEMORY subscale reliability

ranged from a low of .35 to a high of .75; (c) the alpha reliability of the TSTTAK subscale ranged from a low of .48 to a high of .84; and (d) the CONMGT subscale alpha reliability ranged from a low of .82 to a high of .88. Again, reliability coefficients from the WM course tended to be lower on all subscales than the other AIS courses, although the CONMGT subscale demonstrated consistently high reliability across all four AIS courses. One possible explanation for the lower reliability coefficients in the WM course data may be the generally lower variability in these data.

Item-remainder correlations of the individual SSQUES items, with both the total scale and the appropriate subscale, were determined separately for each AIS course. Tables 3 through 6 present the means, standard deviations and item-remainder correlations for the individual items for data from the IM, MF, PME and WM courses, respectively.

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Insert Tables 3 through 6 about here

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As indicated in Tables 3 through 6, five items demonstrated consistently low item remainder correlations with their appropriate subscales across the four AIS courses. These items are: (a) Item 5 on the READCM scale; (b) Items 9, 12 and 14 on the MEMORY scale; and (c) Item 18 on the TSTTAK scale. These items are thus candidates for subsequent revision to increase the overall reliability of the SSQUES and its subscales.

Questionnaire Validity Results. The validity of the SSQUES was assessed in two ways. First, its construct validity was addressed by

determining the extent to which the questionnaire and its subscales demonstrated moderately high intercorrelations and consistent conceptual groupings across the four AIS courses. These construct validity questions were assessed by correlational and factor analyses, respectively. Second, its predictive validity was addressed by determining the extent to which the questionnaire and its subscales were predictive of student performance, in general, and of the performance of particular subgroups. These questions were assessed by regression and discriminant analyses, respectively. Routines from the Statistical Package for the Social Sciences (SPSS; Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975) were utilized in the foregoing analyses.

Construct Validity. As evidence of the construct validity of the SSQUES and its READCM, MEMORY, TSTTAK, and CONMGT subscales, intercorrelation matrices were calculated separately for student data on these measures from each of the four AIS courses. These matrices are shown in Tables 7 through 10 for the IM, MF, PME and WM courses, respectively. The results generally indicate moderate to moderately high intercorrelations between the SSQUES and its subscales, suggesting that the four subscales of the SSQUES are within the same student characteristic variable domain.

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Insert Tables 7 through 10 about here

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A further examination of the Questionnaire's construct validity was conducted via factor analyses of IM and WM course data. Only these two

courses had sample sizes considered adequate for this statistical methodology. Data from the SSQUES and four subscales were combined with student data on the set of affective and cognitive preassessment variables assessed at the beginning of the courses. Descriptions of the variables included in the IM preassessment battery are given in Table 11, along with the appropriate variable labels. The results of the IM factor analysis are shown in Table 12. As can be seen, the study skills variables formed a separate factor following the Varimax rotation procedure. Six definable factors were derived from the preassessment and study skills variables, with the variables from the Study Skills Questionnaire loading on the third factor. Of interest for the construct validity question is that (a) the READCM scale tended to load positively on the Reading/Reasoning, Curiosity, and Media Experience factors; (b) the MEMORY scale tended to load positively on the Reading/Reasoning factor; (c) the TSTTAK scale tended to load negatively on the Anxiety factor and positively on the Reading/Reasoning factor; (d) the CONMGT scale tended to load negatively on the Anxiety factor and positively on the Curiosity factor; and (e) the SSQUES total scale tended to load negatively on the Anxiety factor and positively on the Reading/Reasoning factor.

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Insert Tables 11 and 12 about here

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Descriptions of the variables included on the WM preassessment battery are given in Table 13, together with the appropriate variable labels. The factor analysis results from the WM course, shown in Table 14, are similar

to those found in the IM course. Seven definable factors were derived from the WM preassessment and study skill variable set, with SSQUES variables loading on the second factor. Other findings of interest were that (a) the READCM scale tended to load negatively on the Anxiety factor and positively on the Curiosity factor; (b) the MEMORY scale tended to load negatively on the Anxiety factor and positively on the multiple Media Preference factor; (c) the TSTTAK scale tended to load negatively on the Anxiety factor; (d) the CONMGT scale tended to load negatively on the multiple Media Preference factor and positively on the Curiosity factor; and (e) the SSQUES total scale tended to load negatively on the Anxiety factor and on the multiple Media Preference factor.

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Insert Tables 13 and 14 about here

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Predictive Validity. The question of whether the SSQUES and its subscales could reliably predict student performance in the four AIS courses was examined by regression and discriminant analysis approaches. In the regression analyses, the multiple stepwise methodology was utilized to predict both (a) course completion times and total block scores for those AIS courses with adequate samples (i.e., the IM and MF courses); and (b) individual block times and scores for the IM, MF, and WM courses, utilizing the SSQUES and its four subscales (READCM, MEMORY, TSTTAK, CONMGT) as predictors. (The number of cases for the PME course blocks was less than 25 per block and thus considered too small for the regression methodology.) The results of the first set of regression analyses are shown in Table 15

for the IM and MF courses; the results of the second set of regression analyses are shown in Table 16 for the IM and MF courses, and in Table 17 for the WM course.

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Insert Tables 15, 16, 17 about here

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As shown in Table 15, IM course completion time (Blocks 2 through 6) was reliably predicted by the MEMORY and CONMGT scales with an $R^2$ of .40. The sum of the block scores for IM course Blocks 2 through 6 was reliably predicted by the READCM, TSTTAK, and CONMGT scales with an $R^2$ of .14. The results from the MF course indicated that the MEMORY scale reliably predicted course completion time for Blocks 2 through 5 with an $R^2$ of .15. The sum of MF course block scores for Blocks 2 through 5 was predicted by the TSTTAK and READCM scales with an $R^2$ of .26.

Tables 16 and 17 indicate variable findings regarding the effectiveness of the study skills variables in predicting individual block times (BETA variables) and scores (BSCR variables) in the three AIS courses. In the IM course, the MEMORY, SSQUES, and CONMGT variables appeared to do the best job in predicting block completion times, accounting for between 18 and 35 percent of the variance ($R^2$). On the other hand, the TSTTAK, CONMGT, and READCM variables appeared to do the best job of predicting IM course block scores, with $R^2$s ranging between .04 and .13. The MF results indicated that the MEMORY, TSTTAK, and CONMGT variables best predicted block times ($R^2$s between .03 and .14), and the TSTTAK, READCM, and CONMGT variables best predicted block scores ($R^2$s between .08 and .26). In the WM course,

the CONMGT variable appeared to be the best predictor of individual block times, with the other study skills variables sometimes entering the prediction, and with the $R^2$s ranging between .03 and .13. The best predictors of individual block scores in the WM course were the MEMORY and CONMGT variables, accounting for between five and 19 percent of the variance ($R^2$).

The purpose of the second category of predictive validity analyses was to determine if the various study skills variables could reliably distinguish students in the least efficient and least effective quartiles, on the block and lesson completion time and score criterion variables, from those remaining 75 percent of the students who were having less difficulty completing the course quickly and successfully. These analyses were restricted to the IM and WM courses since these courses had the largest numbers of student samples available on the SSQUES administered at the end of the first block.

In the IM course, block level data considered appropriate for discriminant analyses were block completion times on Blocks 2 through 5, block test failures on an early (Block 2) and a late (Block 5) block, and block test scores on these same two blocks. In addition, cumulative lesson completion times and average lesson test scores were examined for these two blocks.

Results of the discriminant analyses on the IM block level data are reported in Table 18. The results indicated that the study skills variables were moderately effective in discriminating slow from fast students, correctly classifying between 61.3 and 69.8 percent of the students, with a slight gain in predictability from the early to later blocks. When

completion times across the four blocks were summed, the scales were quite effective in reliably discriminating the slowest quarter of the students from the remaining students, correctly classifying 67.8 percent of the students.

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Insert Table 13 about here

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With respect to number of block test failures, the scales were moderately effective in discriminating students with one or more block test failures from those who passed the block tests on the first attempt. In this case, predictability actually improved somewhat from the second (58.2 percent correctly classified) to the fifth (61.8 percent correctly classified) block.

Finally, it was considered of interest to determine the scales' power to discriminate the bottom quarter of the block test score distribution from the remaining 75 percent. Again, the scales were found to be quite effective in discriminating between these two groups and, again, predictability was found to improve slightly from the second to the fifth block (63.0 versus 64.3 percent correctly classified). When Block 2 through 5 scores were summed and the lowest 25 percent discriminated from the remaining 75 percent, 65.1 percent of the students were correctly classified.

In general, these results indicate that the MEMORY, SSQUES and CONMGT scales appeared to be most effective in predicting block times. On the other hand, the SSQUES, MEMORY and TSTTAK scales appeared to be most effective in predicting block failures and test scores.

Results of the lesson level discriminant analyses on the early (Block 2) and late (Block 5) blocks of the IM course are shown in Table 19. Again, it should be noted that the analyses discriminated the performance of the bottom 25 percent of the students from the remaining 75 percent with respect to lesson completion times and scores. The cutoff values shown refer to cumulative lesson completion times and average first attempt lesson test scores for all of the lessons within each of the blocks. The study skills scales were found to be moderately effective in reliably discriminating between these two groups on both the time and score dimensions, with the percent of students correctly classified ranging from 61.2 to 66.1 percent. It is important to note that there was no great loss (apparently, in fact, a slight gain for the time variable) in predictability from the early to the later block. The TSTTAK and SSQUES total scales were most effective in discriminating between groups on the time dimension, while TSTTAK and CONMGT scales appeared to do the best job in discriminating between groups with respect to lesson scores.

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Insert Table 19 about here

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In the WM course, which consisted of 14 blocks, the number of cases available in the later blocks was consistently less than 100 per block, which would imply large instability in parameter estimation. Therefore, the block level data considered appropriate for analysis in the WM course consisted of block completion times for Blocks 2 through 8, block test failures on an early (Block 2) and a relatively late (Block 8) block, and block test

scores on these same two blocks. Cumulative lesson completion times and average lesson test scores were also examined for these two blocks.

Results of the discriminant analyses for the WM block level data are reported in Table 20. The same procedures were followed as for the IM course analyses. The results indicated that the study skills variables were moderately effective in discriminating inefficient (lowest 25 percent) from efficient (remaining 75 percent) students with respect to individual block completion times. Excluding Blocks 3 and 7, (in which the Chi Square values were not significant at the $p < .05$ level), between 61.0 and 75.7 percent of the students were correctly classified. When completion times were summed across the seven blocks, the scales were quite effective in reliably discriminating the slowest quarter of the students from the remaining 75 percent, correctly classifying 68.9 percent of the students.

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Insert Table 20 about here

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In Blocks 2 and 8, the scales were highly effective in discriminating students with one or more block test failures from those who passed the block tests on the first attempt. As had been the case for the IM course, predictability actually increased from the earlier (Block 2, 68.3 percent correctly classified) to the later (Block 8, 71.9 percent correctly classified) blocks.

The four study skills scales were only fairly effective in discriminating the lowest quarter of the students from the remaining 75% with respect to the block test score distribution, with 56.8 percent of the students

classified in Block 2 (Chi-Square not significant at $p < .05$), and 59.6 percent correctly classified in Block 8. When Block 2 through 8 scores were summed, however, the discriminate results were much improved, with 69.3 percent of the students correctly classified.

In general, it appears that the SSQUES total scale was most effective in predicting block completion times, while the READCM and TSTTAK scales were most effective in predicting block test failures and scores.

Results of the lesson level discriminant analyses on the early (Block 2) and late (Block 8) portions of the WM course are presented in Table 21. As was the case for the IM lesson level analyses, the two student categories defined on each (time and score) dimension were those considered to be displaying unsatisfactory (bottom 25 percent) or satisfactory (remaining 75 percent) performance. Again, the cutoff values shown pertain to cumulative lesson completion times across all lessons in the block and average first attempt lesson test scores for all lessons having cognitive criterion tests. The study skills scales were moderately effective in discriminating between the two groups in terms of time (61.0 and 68.2 percent correctly classified), but less effective in discriminating between groups on the score dimension (54.8 and 57.9 percent correctly classified). Once again, there is a consistent pattern of increasing predictability from the earlier to the later block. The SSQUES total and TSTTAK scales appeared to be the most effective in discriminating students categorized into the Low Group from those in the High Group, with SSQUES being more effective on the time dimension and TSTTAK being more effective on the score dimension.

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Insert Table 21 about here

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Finally, of interest in assessing the predictive validity of the SSQUES and its subscales was the question of the relative power of these variables to discriminate the poorest quarter of students on the lesson and block time and score dimensions from the remaining 75 percent of the students, as compared with the standard set of preassessment predictors utilized in the IM and WM courses. To answer this question, the same set of discriminant analyses were calculated on the IM and WM course data as had been calculated with only the SSQUES variables. For the IM course, the preassessment predictor set consisted of 24 course-specific cognitive, affective, and background information predictors (see Table 11); for the WM course, the preassessment predictor set consisted of 26 course-specific predictors (see Table 13).

The results of the IM course analyses generally indicated that the preassessment set correctly classified approximately (a) three percent more students on the block time criterion; (b) nine percent more students on the block score criterion; (c) an average of five percent more students on the lesson time criterion; and (d) an average of four and a half percent more students on the lesson score criterion, as compared to the questionnaire analyses.

The WM course analyses yielded similar results, indicating that the preassessment set correctly classified approximately (a) 21 percent more students on the block time criterion; (b) 11 percent more students on the

block score criterion; (c) an average of five percent more students on the lesson time criterion; and (d) an average of 15 percent more students on the lesson score criterion, as compared to the questionnaire analyses. Thus, the larger preassessment sets were able to correctly classify a larger proportion of the students, particularly at the block level in the WM course. An additional set of discriminant analyses, however, which utilized variables from both the questionnaire and preassessment sets indicated that for both the IM and WM courses, all five of the SSQUES variables were in the set of the most significant predictors of group membership for the lesson and block level analyses (as defined by changes in the Raos V discrimination index).

## Discussion

The present study had the purpose of evaluating the potential usefulness (reliability, construct and predictive validity) of a new study skills measure for (a) predicting student performance in a self-paced, individualized, or computer-managed instructional environment, and (b) identifying students in need of some type of study skills remediation. The results indicate that the SSQUES and its subscales demonstrated good reliability and preliminary construct validity. The differential construct validity relationships shown in the factor analysis results for the IM and WM courses suggest that, within different trainee populations, different patterns of cognitive and affective student characteristics are related to the students' ratings of their study skills in the reading comprehension, memorization, concentration management, and test taking areas.

In addition to the findings of theoretically meaningful but differential

factor analytic relationships, the data in both courses revealed a conceptually distinct study skills factor, indicating support for the construct validity of the SSQUES. Of further relevance is the finding that both cognitive and affective variables tend to be related to variables in the study skills domain, suggesting the need for both cognitive and affective remedial strategies in dealing with study skills problems. Rutkowski and Domino (1975) reached a similar conclusion when examining the effectiveness of a cognitive training program for improving study skills, and they recommended that further efforts to ameliorate study skills problems also take personality variables into account.

With respect to the validity of the SSQUES for predicting student performance (times, scores) in the AIS environment, it is important to note that the degree to which the SSQUES variables correlated with subsequent student performance did not decrease as a function of time in the course and, in several cases, actually improved from early to late course blocks. The strength of the correlations of the study skills variables with student performance was found to be a function of both the type of criterion variable (time versus score) and the nature of the instructional unit (type of block or lesson). These correlations were encouraging, however, in that the SSQUES variables were found to account for as much as 25 to 40 percent of the variance in student performance. It is also of interest that different patterns of predictor relationships were found for differing criterion variables, suggesting that the SSQUES variables are sensitive predictors of both different kinds of performance criteria and different kinds of course content. These predictive validity findings, then, provide

some support for the hypothesis that a combination of self-rating items and items which ask students to describe their skills are useful in effectively predicting student performance.

The results of the analyses which examined the ability of the SSQUES and its subscales to discriminate groups of students who would perform poorly versus satisfactorily in the AIS environment indicated that the SSQUES variables were consistently able to correctly classify between 60 and 70 percent of the students. Even though it might be argued that the larger preassessment variable set available in the AIS environment was somewhat more effective than the SSQUES variables in discriminating poorly versus satisfactorily performing groups of students, there are a number of issues raised by these findings.

First, for those individualized or computer-based environments which do not support preassessment testing or the use of precourse student data in performance predictions, it may be more efficient to simply implement the SSQUES for predictive and diagnostic purposes, rather than designing and implementing some type of precourse assessment procedure. The second issue is related to the intended use of the SSQUES in self-paced, individualized or computer-based environments as a prescriptive and/or diagnostic tool. On the basis of the present findings, it would appear that the questionnaire could at least be used to supplement the prediction of student performance, in that it serves a highly useful function in the diagnosis of particular student study skill weaknesses, and thus facilitates the instructor's remediation decisions. Finally, the short length and short administration time (approximately five to 10 minutes)

makes this measure attractive for situations where "time is of the essence" or the amount of student time available for precourse testing is limited.

The reported validity results and conclusions are, of course, tentative until substantiated in cross-validation studies. Furthermore, additional research on the independent contribution of the two types of items used in the SSQUES (comparative self-rating and self-description) would be helpful in answering measurement questions in the psychometric domain and theoretical questions in the individual differences domain. Related to further research with the SSQUES is the possibility of enhancing both the reliability and validity of this measure by instructions to students which encourage them to answer all items as truthfully as possible. For example, Bornstein et al. (1977) report that taking the time to tell students that they are independent thinkers, that they are believed to have high integrity and to be able to evaluate themselves honestly, and that inaccurate reporting of data would result in loss of time, money and energy, has the payoff of increasing the fidelity of self-reports.

## Conclusions

The following conclusions can be drawn from the preliminary SSQUES validation results:

(1) A combination of self-rating and self-description of study skills items in areas identified as important in a CMI environment (reading comprehension, memorization, test taking, concentration management) is both a reliable and valid method of assessing areas of student strengths and weaknesses. The fidelity of this measure might be further enhanced by in-

corporating instructions which stress the importance of honest answers.

(2) The SSQUES in its present form has sufficient predictive validity to be of use to instructors in the prediction and/or diagnosis of those students expected to have difficulty completing their course efficiently and effectively.

(3) The SSQUES could be used as a reliable diagnostic and/or prescriptive tool in lieu of the battery of precourse assessment procedures or as a supplement to these procedures.

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## Footnotes

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Table 1

The Study Skills Questionnaire (SSQUES)

| | Item | Subscale |
|---|---|---|
| 1. | I get deeply involved with material I am studying (i.e., I really think about it rather than just trying to memorize it). | READCM |
| | a. almost always<br>b. most of the time<br>c. some of the time<br>d. almost never | |
| 2. | If I am reading some course material and cannot understand it, I keep going anyway in order to finish the assignment. | READCM |
| | a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | |
| 3. | I would rate my ability to read and remember technical information as: | READCM |
| | a. well above average<br>b. above average<br>c. below average<br>d. well below average | |
| 4. | I would rate my ability to take good text notes as: | READCM |
| | a. well below average<br>b. below average<br>c. above average<br>d. well above average | |
| 5. | In comparison to the amount of time spent reading your notes and the textbooks, how much time do you spend testing yourself on the material when studying for an exam? | READCM |
| | a. a large amount of time<br>b. a moderate amount of time<br>c. a small amount of time<br>d. generally not at all | |
| 6. | When you can't understand what you're reading, do you try to figure it out? | READCM |
| | a. almost always<br>b. most of the time<br>c. some of the time<br>d. almost never | |
| 7. | You finish reading a lesson and find that you don't remember what you read. How often does this happen to you? | READCM |
| | a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | |

Table 1 (Continued)

| | Item | Subscale |
|---|---|---|
| 8. | I think it is easy to find the main idea of a paragraph or passage.<br>a. almost always<br>b. most of the time<br>c. some of the time<br>d. almost never | READCM |
| 9. | Do you try to find personel meaning in the technical material to help you remember it?<br>a. almost never<br>b. some of the time<br>c. most of the time<br>d. almost always | MEMORY |
| 10. | My memory for facts is:<br>a. well above average<br>b. above average<br>c. below average<br>d. well below average | MEMORY |
| 11. | You have read some material for a lesson and you feel that you understood pretty much what was being said. A classmate then asks you a question on the material or you try to recall some of the material yourself and find you can't remember much of what you have read. How often does this happen to you?<br>a. very frequently<br>b. frequently<br>c. sometimes<br>d. almost never | MEMORY |
| 12. | When it's necessary for you to memorize material, how much time do you spend memorizing it?<br>a. more than 1/2 my study time<br>b. 1/2 of my study time<br>c. 1/4 to 1/2 of my study time<br>d. I don't memorize material | MEMORY |
| 13. | To memorize something, I repeat it to myself many times.<br>a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | MEMORY |
| 14. | To memorize something, I write it down several times.<br>a. very frequently<br>b. frequently<br>c. sometimes<br>d. almost never | MEMORY |
| 15. | How would you rate your ability to memorize and remember information?<br>a. well above average<br>b. above average<br>c. below average<br>d. well below average | MEMORY |

Table 1 (Continued)

| Item | Subscale |
|---|---|
| 16. I would rate my ability to do well on multiple choice tests as:<br>a. well above average<br>b. above average<br>c. below average<br>d. well below average | TSTTAK |
| 17. I usually read the test directions very carefully.<br>a. very frequently<br>b. frequently<br>c. sometimes<br>d. almost never | TSTTAK |
| 18. I would rate my ability to finish tests on time as:<br>a. well below average<br>b. below average<br>c. above average<br>d. well above average | TSTTAK |
| 19. You are taking a test and you come to a question for which you are sure you know the answer, but you just can't quite remember it. How often does this happen?<br>a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | TSTTAK |
| 20. When taking an exam, I am usually feeling _____.<br>a. very relaxed<br>b. relatively relaxed<br>c. somewhat nervous and uptight<br>d. very nervous and uptight | TSTTAK |
| 21. You study very hard and you know that you understand the material but when you set down to take the test, you forget everything you knew. How often does this happen to you?<br>a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | TSTTAK |
| 22. I would rate my ability to concentrate (compared to other students) as:<br>a. well above average<br>b. above average<br>c. below average<br>d. well below average | CONMGT |
| 23. I would rate my ability to deal with distractions that occur while I'm studying as:<br>a. well below average<br>b. below average<br>c. above average<br>d. well above average | CONMGT |

Table 1 (Continued)

| Item | Subscale |
|---|---|
| 24. I would rate my ability to keep my feelings and emotions from interfering with my school work as:<br>a. well below average<br>b. below average<br>c. above average<br>d. well above average | CONMGT |
| 25. I would rate my ability to deal with distractions that occur while I'm taking a test as:<br>a. well above average<br>b. above average<br>c. below average<br>d. well below average | CONMGT |
| 26. Once I get started, I find it easy to continue studying for a relatively long time.<br>a. almost always<br>b. most of the time<br>c. some of the time<br>d. almost never | CONMGT |
| 27. I enjoy studying. I am usually in a good mood when I am studying.<br>a. almost never<br>b. some of the time<br>c. most of the time<br>d. almost always | CONMGT |
| 28. You are studying a lesson. After reading a number of paragraphs, you suddenly realize you have no idea what you just read because you have been thinking of other things. How often does that happen to you?<br>a. very frequently<br>b. frequently<br>c. sometimes<br>d. almost never | CONMGT |
| 29. I get sleepy when I start to study.<br>a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | CONMGT |
| 30. If other students are studying near me, I have trouble blocking out noise in the room.<br>a. almost never<br>b. sometimes<br>c. frequently<br>d. very frequently | CONMGT |

Table 2

Means, Standard Deviations, and Alpha Reliabilities of Study Skills Questionnaire Total Scale and Subscales Administered in Four AIS Courses

| Course | Scale | Score Range | N | Mean | SD | Alpha |
|---|---|---|---|---|---|---|
| IM | SSQUES | 30 - 120 | 313 | 81.0 | 17.5 | .75 |
| | READCM | 8 - 32 | 313 | 22.9 | 5.1 | .87 |
| | MEMORY | 7 - 28 | 313 | 17.3 | 4.1 | .73 |
| | TSTTAK | 6 - 24 | 313 | 16.6 | 4.0 | .82 |
| | CONMGT | 9 - 36 | 313 | 24.1 | 6.1 | .88 |
| MF | SSQUES | 30 - 120 | 92 | 81.7 | 16.1 | .94 |
| | READCM | 8 - 32 | 92 | 23.2 | 4.5 | .82 |
| | MEMORY | 7 - 28 | 92 | 16.7 | 4.0 | .75 |
| | TSTTAK | 6 - 24 | 92 | 16.5 | 4.0 | .84 |
| | CONMGT | 9 - 36 | 92 | 25.3 | 5.8 | .88 |
| PME | SSQUES | 30 - 120 | 79 | 82.6 | 13.7 | .91 |
| | READCM | 8 - 32 | 79 | 23.2 | 4.2 | .80 |
| | MEMORY | 7 - 28 | 79 | 18.0 | 3.5 | .55 |
| | TSTTAK | 6 - 24 | 79 | 16.8 | 3.2 | .75 |
| | CONMGT | 9 - 36 | 79 | 24.6 | 5.1 | .84 |
| WM | SSQUES | 30 - 120 | 297 | 85.1 | 9.3 | .81 |
| | READCM | 8 - 32 | 297 | 24.1 | 2.3 | .58 |
| | MEMORY | 7 - 28 | 297 | 18.2 | 2.5 | .35 |
| | TSTTAK | 6 - 24 | 297 | 18.0 | 2.2 | .48 |
| | CONMGT | 9 - 36 | 297 | 24.9 | 5.4 | .82 |

TABLE 3

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in IM Course (N=313)

| Subscale/Item | | Mean | SD | Item Remainder | |
|---|---|---|---|---|---|
| | | | | Total | Subscale |
| READCM | 1 | 2.72 | .92 | .62 | .65 |
| | 2 | 3.05 | 1.04 | .55 | .48 |
| | 3 | 2.71 | .74 | .77 | .70 |
| | 4 | 2.69 | .80 | .67 | .63 |
| | 5 | 2.91 | .91 | .59 | .58 |
| | 6 | 3.32 | .93 | .68 | .68 |
| | 7 | 2.77 | .89 | .71 | .60 |
| | 8 | 2.77 | .89 | .69 | .66 |
| MEMORY | 9 | 2.60 | 1.03 | .49 | .35 |
| | 10 | 2.41 | 178 | .69 | .58 |
| | 11 | 2.86 | .86 | .73 | .63 |
| | 12 | 2.05 | .99 | .33 | .26 |
| | 13 | 2.05 | .95 | .38 | .40 |
| | 14 | 2.63 | 1.14 | .39 | .39 |
| | 15 | 2.70 | .75 | .79 | .63 |
| TSTTAK | 16 | 2.82 | .78 | .73 | .71 |
| | 17 | 3.15 | .98 | .61 | .51 |
| | 18 | 2.59 | 1.02 | .43 | .37 |
| | 19 | 2.65 | .83 | .69 | .66 |
| | 20 | 2.32 | .86 | .65 | .64 |
| | 21 | 3.10 | 1.05 | .69 | .65 |
| CONMGT | 22 | 2.67 | .79 | .77 | .71 |
| | 23 | 2.43 | .84 | .69 | .70 |
| | 24 | 2.69 | .99 | .60 | .60 |
| | 25 | 2.69 | .90 | .66 | .67 |
| | 26 | 2.68 | .96 | .63 | .60 |
| | 27 | 2.48 | .89 | .62 | .62 |
| | 28 | 2.69 | .94 | .73 | .70 |
| | 29 | 2.94 | 1.03 | .59 | .57 |
| | 30 | 2.86 | 1.11 | .59 | .60 |

TABLE 4

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in MF Course (N=92)

| Subscale/Item | | Mean | SD | Item Remainder | |
|---|---|---|---|---|---|
| | | | | Total | Subscale |
| READCM | 1 | 2.72 | .86 | .60 | .57 |
| | 2 | 3.14 | 1.03 | .53 | .51 |
| | 3 | 2.61 | .66 | .66 | .57 |
| | 4 | 2.86 | .79 | .58 | .55 |
| | 5 | 2.83 | .82 | .52 | .51 |
| | 6 | 3.30 | .92 | .60 | .55 |
| | 7 | 2.80 | .84 | .72 | .55 |
| | 8 | 2.91 | .85 | .58 | .52 |
| MEMORY | 9 | 2.53 | .93 | .54 | .24 |
| | 10 | 2.34 | .86 | .62 | .55 |
| | 11 | 2.86 | .76 | .74 | .65 |
| | 12 | 1.93 | .97 | .34 | .33 |
| | 13 | 1.97 | .88 | .47 | .60 |
| | 14 | 2.46 | 1.13 | .31 | .39 |
| | 15 | 2.60 | .80 | .71 | .61 |
| TSTTAK | 16 | 2.84 | .77 | .73 | .71 |
| | 17 | 3.11 | .92 | .60 | .49 |
| | 18 | 2.77 | .93 | .52 | .46 |
| | 19 | 2.60 | .77 | .69 | .72 |
| | 20 | 2.25 | .83 | .68 | .66 |
| | 21 | 2.91 | 1.08 | .65 | .70 |
| CONMGT | 22 | 2.79 | .76 | .69 | .72 |
| | 23 | 2.64 | .90 | .61 | .64 |
| | 24 | 2.84 | .91 | .65 | .65 |
| | 25 | 2.84 | .83 | .65 | .66 |
| | 26 | 2.76 | .97 | .56 | .65 |
| | 27 | 2.58 | .91 | .52 | .50 |
| | 28 | 2.67 | .88 | .65 | .58 |
| | 29 | 3.05 | .95 | .59 | .66 |
| | 30 | 3.15 | .96 | .64 | .61 |

TABLE 5

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in PME Course (N=79)

| Subscale/Item | | Mean | SD | Item Remainder | |
|---|---|---|---|---|---|
| | | | | Total | Subscale |
| READCM | 1 | 2.84 | .79 | .51 | .53 |
| | 2 | 3.20 | .88 | .58 | .51 |
| | 3 | 2.70 | .77 | .65 | .57 |
| | 4 | 2.77 | .72 | .60 | .50 |
| | 5 | 2.65 | .99 | .40 | .38 |
| | 6 | 3.39 | .76 | .67 | .65 |
| | 7 | 2.73 | .73 | .60 | .49 |
| | 8 | 2.91 | .77 | .63 | .57 |
| MEMORY | 9 | 2.34 | 1.04 | .48 | .35 |
| | 10 | 2.43 | .80 | .49 | .51 |
| | 11 | 2.86 | .76 | .58 | .46 |
| | 12 | 1.94 | 1.28 | .20 | .06 |
| | 13 | 2.68 | .97 | .28 | .03 |
| | 14 | 2.96 | 1.01 | .28 | .24 |
| | 15 | 2.81 | .68 | .62 | .57 |
| TSTTAK | 16 | 2.81 | .62 | .61 | .56 |
| | 17 | 3.28 | .88 | .59 | .48 |
| | 18 | 2.65 | .82 | .28 | .25 |
| | 19 | 2.82 | .66 | .58 | .56 |
| | 20 | 2.18 | .78 | .40 | .50 |
| | 21 | 3.10 | 1.00 | .61 | .67 |
| CONMGT | 22 | 2.77 | .62 | .77 | .71 |
| | 23 | 2.58 | .71 | .63 | .59 |
| | 24 | 2.72 | .89 | .44 | .33 |
| | 25 | 2.70 | .74 | .60 | .61 |
| | 26 | 2.70 | .91 | .61 | .55 |
| | 27 | 2.47 | .92 | .56 | .57 |
| | 28 | 2.68 | .84 | .71 | .64 |
| | 29 | 3.05 | .86 | .63 | .60 |
| | 30 | 2.91 | 1.12 | .48 | .52 |

TABLE 6

Means, Standard Deviations, and Item-Remainder Correlations for Study Skills Questionnaire Total Scale and Subscales in WM Course (N=297)

| Subscale/Item | | Mean | SD | Item Remainder | |
|---|---|---|---|---|---|
| | | | | Total | Subscale |
| READCM | 1 | 3.00 | .69 | .44 | .56 |
| | 2 | 3.35 | .73 | .19 | .23 |
| | 3 | 2.80 | .56 | .36 | .29 |
| | 4 | 2.68 | .67 | .28 | .22 |
| | 5 | 2.83 | .70 | .17 | .15 |
| | 6 | 3.44 | .69 | .23 | .26 |
| | 7 | 3.05 | .70 | .50 | .29 |
| | 8 | 2.93 | .74 | .44 | .39 |
| MEMORY | 9 | 2.60 | .88 | .22 | -.01 |
| | 10 | 2.49 | .71 | .38 | .33 |
| | 11 | 3.05 | .65 | .62 | .30 |
| | 12 | 2.21 | .90 | .14 | .07 |
| | 13 | 2.12 | .86 | .04 | .15 |
| | 14 | 2.81 | .98 | -.10 | .05 |
| | 15 | 2.87 | .52 | .45 | .37 |
| TSTTAK | 16 | 3.04 | .53 | .30 | .27 |
| | 17 | 3.21 | .74 | .32 | .16 |
| | 18 | 2.77 | .86 | -.05 | -.04 |
| | 19 | 2.90 | .57 | .53 | .44 |
| | 20 | 2.67 | .72 | .47 | .35 |
| | 21 | 3.38 | .75 | .55 | .44 |
| CONMGT | 22 | 2.88 | .58 | .36 | .18 |
| | 23 | 2.71 | .77 | .54 | .62 |
| | 24 | 2.89 | .78 | .47 | .53 |
| | 25 | 2.89 | .77 | .51 | .60 |
| | 26 | 2.65 | .90 | .59 | .62 |
| | 27 | 2.46 | .91 | .56 | .57 |
| | 28 | 2.85 | .83 | .57 | .56 |
| | 29 | 2.76 | 1.27 | .42 | .54 |
| | 30 | 2.80 | 1.32 | .48 | .60 |



TABLE 7

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in IM Course (N=267)

| | READCM | MEMORY | TSTTAK | CONMGT | SSQUES |
|---|---|---|---|---|---|
| READCM | 1.00 | .37 | .43 | .55 | .77 |
| MEMORY | | 1.00 | .39 | .26 | .65 |
| TSTTAK | | | 1.00 | .41 | .72 |
| CONMGT | | | | 1.00 | .77 |
| SSQUES | | | | | 1.00 |

All above correlations are significant at the $p < .001$ level.

TABLE 8

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in MF Course (N=90)

| | READCM | MEMORY | TSTTAK | CONMGT | SSQUES |
|---|---|---|---|---|---|
| READCM | 1.00 | .40 | .48 | .50 | .76 |
| MEMORY | | 1.00 | .61 | .37 | .78 |
| TSTTAK | | | 1.00 | .41 | .77 |
| CONMGT | | | | 1.00 | .72 |
| SSQUES | | | | | 1.00 |

All above correlations are significant at the $p < .001$ level.

TABLE 9

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in PME Course (N=80)

| | READCM | MEMORY | TSTTAK | CONMGT | SSQUES |
|---|---|---|---|---|---|
| READCM | 1.00 | .47 | .38 | .67 | .84 |
| MEMORY | | 1.00 | .23* | .44 | .64 |
| TSTTAK | | | 1.00 | .46 | .64 |
| CONMGT | | | | 1.00 | .88 |
| SSQUES | | | | | 1.00 |

* $p < .05$; all other correlations are significant at the $p < .001$ level.

TABLE 10

Intercorrelations of Initial Measure of Study Skills Questionnaire Variables in WM Course (N=271)

| | READCM | MEMORY | TSTTAK | CONMGT | SSQUES |
|---|---|---|---|---|---|
| READCM | 1.00 | .38 | .48 | .48 | .78 |
| MEMORY | | 1.00 | .41 | .22* | .62 |
| TSTTAK | | | 1.00 | .39 | .71 |
| CONMGT | | | | 1.00 | .81 |
| SSQUES | | | | | 1.00 |

* $p < .01$; all other correlations are significant at the $p < .001$ level.

TABLE 11: Description of IM Preassessment Testing Battery

| Factor | Test and Subscale Names | Test Descriptions | Author |
|---|---|---|---|
| Reading/ Reasoning | Logical Reasoning Test (LOGREA) | Measures student's general ability to judge the logical soundness of meaningful conclusions. | Hertzka & Guilford (1955) |
| Reading/ Reasoning | IM Reading Skills Scale<br>Reading Scale 1 (READS1)<br>Reading Scale 2 (READS2) | Measures student's technical information processing and retention skills, under timed conditions, on materials extracted from IM and MF technical manuals. | McCombs (Note 1) |
| Reading/ Reasoning | Reading Vocabulary Test (RVOCTL) | Measures student's comprehension, under timed conditions, of terms frequently used in Air Force documents and manuals. | Deignan (Note 2) |
| Anxiety/ Curiosity | Attitude Toward Course Materials<br>State Anxiety (STANX)<br>State Curiosity (STCUR) | Measures how tense or apprehensive versus interested or motivated a student feels about learning the IM course materials on an intensity dimension. | Spielberger, Gorsuch & Lushene (1970); McCombs-Leherissey (Note 3) |
| Anxiety | Test Attitude Inventory (TAITL)<br>Test Worry (TAIWY)<br>Test Emotionality (TAIEM)<br>Test Anxiety (TAIEX) | Measures, on a frequence dimension, student's tendency to feel cognitive worry versus emotional versus generally anxious when taking performance or achievement tests. | Spielberger (Note 4) |
| Anxiety | General Attitude Scale<br>Trait Anxiety (TRANX)<br>Trait Curiosity (TRCUR) | Measures student's general tendency to experience feelings of tension and apprehension in situations perceived as threatening versus feelings of interest in a variety of technical areas. | Spielberger et al. (1970); Day (Note 5) |
| Media Preference<br>Media Experience | General Media Preference Scale<br>Visual (PREFV)<br>Audio (PREFA)<br>Print (PREFP)<br>Conventional (EXPCI)<br>Self-Paced (EXPSP) | Measures student's preference for visual versus audio versus printed learning materials, as well as his/her experience with conventional versus self-paced instructional methods | McCombs (Note 6) |

TABLE 12

Varimax Rotated Factor Matrix for IM Course Study Skills Questionnaire and Preassessment Variables (N = 213)

| VARIABLES | FACTOR 1 (Anxiety) | FACTOR 2 (Reading/Reasoning) | FACTOR 3 (Study Skills) | FACTOR 4 (Curiosity) | FACTOR 5 (Media Experience) | FACTOR 6 (Media Preference) |
|---|---|---|---|---|---|---|
| READCM | -.186 | .210 | .669 | .240 | .224 | -.086 |
| MEMORY | -.118 | .178 | .489 | -.033 | -.009 | -.035 |
| TSTTAK | -.469 | .335 | .480 | -.101 | .052 | -.046 |
| CONMGT | -.303 | .001 | .633 | .177 | .099 | -.141 |
| SSQUES | -.341 | .207 | .923 | .101 | .116 | -.108 |
| READS1 | -.068 | .561 | .082 | .090 | .125 | .013 |
| READS2 | -.132 | .592 | .084 | .141 | .079 | -.178 |
| RVOCTL | -.191 | .064 | .148 | .004 | .106 | .019 |
| LOGREA | -.106 | .461 | .141 | .033 | .036 | .091 |
| STANX | .590 | -.138 | -.236 | -.310 | -.013 | .148 |
| STCUR | -.314 | .091 | .140 | .661 | .062 | -.202 |
| TRANX | .538 | -.136 | -.274 | -.372 | -.015 | .085 |
| TRCUR | -.052 | .119 | .036 | .649 | .101 | .039 |
| TAITL | .961 | -.158 | -.201 | -.058 | -.038 | .094 |
| TAIWY | .807 | -.161 | -.252 | -.043 | -.017 | .084 |
| TAIEM | .891 | -.109 | -.153 | -.052 | -.040 | .064 |
| TAIEX | .816 | -.213 | -.186 | -.126 | -.045 | .159 |
| PREFA | .181 | -.003 | -.056 | .165 | -.072 | .478 |
| PREFV | .068 | .007 | -.058 | -.089 | .137 | .492 |
| PREFP | -.032 | .005 | .111 | .322 | .090 | -.487 |
| EXPCI | -.064 | .213 | .100 | .117 | .691 | .058 |
| EXPSP | -.007 | .110 | .109 | .055 | .760 | -.025 |

TABLE 13: Description of WM Course Preassessment Testing Battery

| Factor | Test and Subscale Names | Test Descriptions | Author |
|---|---|---|---|
| Reading/ Reasoning | WM Reading Skills Scale<br>Reading Scale 1 (READS1)<br>Reading Scale 2 (READS2) | Measures student's reading comprehension and speed on materials extracted from WM technical orders and technical manuals. | McCombs (Note 1) |
| Reading/ Reasoning | Reading Vocabulary Test (RVOCTL) | Measures a student's comprehension, under timed conditions, of terms frequently used in Air Force document and manuals. | Deignan (Note 2) |
| Math Skills | Ship Destination Test (SHIPDS) | Measures student's general arithmetic reasoning or problem solving ability, using specific rules to solve problems under timed conditions. | Christensen & Guilford (1955) |
| Math Skills | Math Familiarization Test (MATHFT)<br>Scale 1 (MATHF1)<br>Scale 2 (MATHF2) | Measures student's basic math skills, under timed conditions, on easy and difficult subscales, that are required in certain areas of the WM course. | ATC-Developed |
| Anxiety Curiosity | Attitude Toward Course Materials<br>State Anxiety (STANX)<br>State Curiosity (STCUR) | Measures how tense or apprehensive versus interested or motivated a student feels about learning the WM course materials on an intensity dimension. | Spielberger, Gorsuch & Lushane (1970); McCombs-Leherissey (Note 3) |
| Anxiety | General Attitude Scale<br>Trait Anxiety (TRANX)<br>Trait Curiosity (TRCUR) | Measures, on a frequency dimension, student's general tendency to experience feelings of tension and apprehension in situations perceived as threatening versus feelings of interest in a variety of technical areas. | Spielberger et al. (1970); Day (Note 5) |

TABLE 13 (Continued)

| Factor | Test and Subscale Names | Test Descriptions | Author |
|---|---|---|---|
| Curiosity | Mechanical Curiosity Scale (MECCUR) | Measures student's general feelings of interest, or tendency to become interested in, mechanical devices and mechanical principles. | Author Unknown |
| Anxiety | Test Attitude Inventory (TAITL)<br>Test Worry (TAIWY)<br>Test Emotionality (TAIEM)<br>Test Anxiety (TAIEX) | Measures, on a frequency dimension, student's tendency to feel cognitive worry versus emotional versus generally anxious when taking performance or achievement tests. | Spielberger (Note 4) |
| Media Preference | General Media Preference Scale<br>Visual (PREFV)<br>Audio (PREFA)<br>Print (PREFP) | Measures student's preference for visual versus audio versus printed learning modes, as well as his/her experience with conventional versus self-paced instructional methods. | McCombs (Note 6) |
| Media Experience | Conventional (EXPCI<br>Self-Paced (EXPSP) | | |

TABLE 14

Varimax Rotated Factor Matrix for WM Course Study Skills Questionnaire and Preassessment Variables (N = 271)

| VARIABLES | FACTOR 1 (Anxiety) | FACTOR 2 (Study Skills) | FACTOR 3 (math Skills) | FACTOR 4 (Media Preference) | FACTOR 5 (Curiosity) | FACTOR 6 (Reading/ Reasoning) | FACTOR 7 (Media Experience) |
|---|---|---|---|---|---|---|---|
| READCM | -.202 | .656 | .063 | -.121 | .238 | .050 | .055 |
| MEMORY | -.200 | .611 | .023 | .218 | -.010 | .090 | -.039 |
| TSTTAK | -.488 | .540 | .093 | -.023 | .060 | .095 | .064 |
| CONMGT | -.167 | .590 | .087 | -.456 | .215 | -.069 | .056 |
| SSQUES | -.303 | .927 | .088 | -.206 | .171 | .032 | .047 |
| READS1 | -.208 | .073 | .104 | -.075 | .015 | .455 | .072 |
| READS2 | -.062 | -.049 | .093 | -.001 | .075 | .510 | .088 |
| RVOCTL | -.216 | .127 | .173 | -.061 | -.029 | .511 | .099 |
| SHIPDS | -.143 | .051 | .330 | .070 | -.020 | .358 | .047 |
| STANX | .463 | -.251 | -.134 | .039 | -.398 | -.048 | -.154 |
| STCUR | -.250 | .215 | .016 | -.003 | .647 | .166 | .064 |
| MECCUR | -.009 | .124 | -.017 | .049 | .692 | -.054 | .197 |
| PREFV | .137 | -.036 | -.002 | .482 | .154 | -.052 | .044 |
| PREFA | .146 | .147 | -.047 | .462 | .034 | -.319 | .040 |
| PREFP | -.063 | .124 | -.023 | -.487 | .094 | -.036 | -.073 |
| EXPCI | .008 | .061 | -.007 | .066 | .146 | .159 | .679 |
| EXPSP | -.061 | .002 | .076 | .080 | .100 | .115 | .685 |
| MATHF1 | .036 | .059 | .511 | .035 | -.003 | .140 | -.049 |
| MATHF2 | -.150 | .047 | .881 | -.073 | .025 | .149 | .109 |
| MATHFT | -.109 | .058 | .995 | -.044 | .025 | .164 | .061 |
| TAIWY | .829 | -.232 | -.054 | .156 | -.098 | -.143 | -.008 |
| TAIEM | .895 | -.164 | -.008 | .135 | -.031 | -.123 | .051 |
| TAIEX | .829 | -.217 | -.128 | .127 | -.048 | -.132 | -.069 |
| TAITL | .959 | -.205 | -.052 | .150 | -.059 | -.136 | .003 |

TABLE 15

Multiple Stepwise Regression Results for IM and MF Course Total Completion Time and Score Variables

| Course/ Criterion Variables | N | Total $R^2$ | Predictor Variables | Increase in $R^2$ |
|---|---|---|---|---|
| IM Course (Blocks 2-6) | | | | |
| Completion Time | 88 | .40 | MEMORY | .34 |
| | | | CONMGT | .06 |
| Sum of Block Scores | 105 | .14 | READCM | .09 |
| | | | TSTTAK | .03 |
| | | | CONMGT | .02 |
| MF Course (Blocks 2-5) | | | | |
| Completion Time | 50 | .15 | MEMORY | .15 |
| Sum of Block Scores | 70 | .26 | TSTTAK | .21 |
| | | | READCM | .05 |

TABLE 16

Multiple Stepwise Regression Results for the IM and MF Course Individual Block Completion Time and Score Variables

| Course/ Criterion Variables | N | Total $R^2$ | Predictor Variables | $R^2$ Increase |
|---|---|---|---|---|
| **IM Course** | | | | |
| Block 2 Time (BETA02) | 104 | .35 | SSQUES | .30 |
| | | | MEMORY | .05 |
| Block 3 Time (BETA03) | 104 | .29 | SSQUES | .27 |
| | | | MEMORY | .02 |
| Block 4 Time (BETA04) | 101 | .18 | MEMORY | .15 |
| | | | CONMGT | .03 |
| Block 5 Time (BETA05) | 103 | .28 | MEMORY | .22 |
| | | | CONMGT | .06 |
| Block 6 Time (BETA06) | 96 | .21 | SSQUES | .16 |
| | | | READCM | .03 |
| | | | TSTTAK | .02 |
| Block 2 Score (BSCR02) | 105 | .04 | MEMORY | .04 |
| Block 3 Score (BSCR03) | 105 | .13 | TSTTAK | .10 |
| | | | READCM | .03 |
| Block 4 Score (BSCR04) | 105 | .06 | TSTTAK | .02 |
| | | | CONMGT | .02 |
| | | | READCM | .02 |
| Block 5 Score (BSCR05) | 105 | .10 | SSQUES | .08 |
| | | | CONMGT | .02 |
| Block 6 Score (BSCR06) | 105 | .09 | READCM | .05 |
| | | | CONMGT | .02 |
| | | | TSTTAK | .02 |
| **MF Course** | | | | |
| Block 2 Time (BETA02) | 69 | .07 | CONMGT | .07 |
| Block 3 Time (BETA03) | 68 | .14 | MEMORY | .11 |
| | | | TSTTAK | .03 |
| Block 4 Time (BETA04) | 64 | .09 | TSTTAK | .09 |
| Block 5 Time (BETA05) | 59 | .03 | MEMORY | .03 |
| Block 2 Score (BSCR02) | 70 | .13 | TSTTAK | .13 |
| Block 3 Score (BSCR03) | 71 | .26 | TSTTAK | .16 |
| | | | READCM | .04 |
| | | | CONMGT | .06 |
| Block 4 Score (BSCR04) | 71 | .21 | TSTTAK | .16 |
| | | | READCM | .05 |
| Block 5 Score (BSCR05) | 71 | .08 | READCM | .08 |

TABLE 17

Multiple Stepwise Regression Results for the WM Course Individual Block Completion Time and Score Variables

| Criterion Variables | N | Total $R^2$ | Predictor Variables | $R^2$ Increase |
|---|---|---|---|---|
| **Block Times** | | | | |
| Block 2 Time (BETA02) | 46 | | None Sig. | |
| Block 3 Time (BETA03) | 46 | .04 | TSTTAK | .04 |
| Block 4 Time (BETA04) | 46 | .03 | CONMGT | .03 |
| Block 5 Time (BETA05) | 42 | .04 | READCM | .04 |
| Block 6 Time (BETA06) | 44 | | None Sig. | |
| Block 7 Time (BETA07) | 43 | .12 | CONMGT | .12 |
| Block 8 Time (BETA08) | 44 | .08 | CONMGT | .08 |
| Block 9 Time (BETA09) | 33 | | None Sig. | |
| Block 10 Time (BETA10) | 44 | | None Sig. | |
| Block 11 Time (BETA11) | 46 | .13 | READCM | .09 |
| | | | TSTTAK | .04 |
| Block 12 Time (BETA12) | 46 | .18 | CONMGT | .11 |
| | | | TSTTAK | .04 |
| | | | MEMORY | .03 |
| Block 13 Time (BETA13) | 43 | .07 | CONMGT | .07 |
| Block 14 Time (BETA14) | 42 | .11 | CONMGT | .05 |
| | | | SSQUES | .06 |
| **Block Scores** | | | | |
| Block 2 Score (BSCR02) | 46 | | None Sig. | |
| Block 3 Score (BSCR03) | 46 | .18 | MEMORY | .09 |
| | | | READCM | .09 |
| Block 4 Score (BSCR04) | 46 | .05 | MEMORY | .05 |
| Block 5 Score (BSCR05) | 45 | | None Sig. | |
| Block 6 Score (BSCR06) | 46 | .06 | CONMGT | .06 |
| Block 7 Score (BSCR07) | 45 | | None Sig. | |
| Block 8 Score (BSCR08) | 46 | | None Sig. | |
| Block 9 Score (BSCR09) | 46 | .19 | CONMGT | .07 |
| | | | TSTTAK | .05 |
| | | | READCM | .07 |
| Block 10 Score (BSCR10) | 46 | .17 | MEMORY | .17 |
| Block 11 Score (BSCR11) | 46 | .13 | CONMGT | .13 |
| Block 12 Score (BSCR12) | 46 | | None Sig. | |
| Block 13 Score (BSCR13) | 46 | .16 | MEMORY | .06 |
| | | | SSQUES | .10 |

TABLE 18

IM Course Discriminant Analysis Results for Block Level Data

| Criterion Variables | Bottom 25% Cutoff | Bottom 25% N | Remaining 75% Cutoff | Remaining 75% N | $X^2$ | % Correctly Classified | Order of Predictors |
|---|---|---|---|---|---|---|---|
| Block 2 Time (in minutes) | 1877 | 67 | 1877 | 202 | 36.4** | 68.4% | MEMORY<br>SSQUES<br>READCM<br>CONMGT<br>TSTTAK |
| Block 3 Time (in minutes) | 1678 | 72 | 1678 | 220 | 24.2** | 64.4% | MEMORY<br>SSQUES<br>CONMGT<br>READCM<br>TSTTAK |
| Block 4 Time (in minutes) | 1154 | 71 | 1154 | 211 | 14.5** | 61.3% | CONMGT<br>MEMORY<br>READCM<br>TSTTAK |
| Block 5 Time (in minutes) | 1733 | 74 | 1733 | 221 | 46.4** | 69.8% | SSQUES<br>MEMORY<br>READCM<br>CONMGT<br>TSTTAK |
| Block 2-5 Time (in minutes) | 6545 | 61 | 6545 | 181 | 30.6** | 67.8% | MEMORY<br>SSQUES<br>CONMGT<br>READCM<br>TSTTAK |
| Block 2 Failures | 1 | 45 | 0 | 168 | 5.8* | 58.2% | CONMGT<br>TSTTAK<br>SSQUES |
| Block 3 Failures | 1 | 70 | 0 | 158 | 12.8** | 61.8% | MEMORY<br>TSTTAK<br>SSQUES |
| Block 2 Score | 73 | 79 | 73 | 221 | 20.3** | 63.0% | SSQUES<br>MEMORY<br>READCM<br>CONMGT<br>TSTTAK |
| Block 5 Score | 69 | 60 | 69 | 240 | 24.7** | 64.3% | MEMORY<br>SSQUES<br>TSTTAK<br>CONMGT<br>READCM |
| Block 2-5 Score | 296 | 74 | 296 | 224 | 27.2** | 65.1% | TSTTAK<br>SSQUES<br>MEMORY<br>CONMGT<br>READCM |

* $p < .01$ ** $p < .001$

TABLE 19

IM Course Discriminant Analysis Results for Lesson Level Data

| Criterion Variables | Bottom 25% Cutoff | N | Remaining 75% Cutoff | N | $X^2$ | % Correctly Classified | Order of Predictors |
|---|---|---|---|---|---|---|---|
| Block 2 | | | | | | | |
| Lesson Time | 1732 | 55 | 1732 | 164 | 11.0* | 61.2% | TSTTAK<br>SSQUES<br>MEMORY<br>CONMGT |
| Lesson Score | 579 | 55 | 579 | 172 | 18.6** | 64.3% | TSTTAK<br>SSQUES<br>CONMGT<br>READCM<br>MEMORY |
| Block 5 | | | | | | | |
| Lesson Time | 1416 | 71 | 1416 | 209 | 28.9** | 66.1% | SSQUES<br>MEMORY<br>READCM<br>CONMGT<br>TSTTAK |
| Lesson Score | 606 | 70 | 606 | 217 | 18.6** | 62.7% | CONMGT<br>SSQUES<br>MEMORY<br>TSTTAK<br>READCM |

* $p < .01$
** $p < .001$

TABLE 20

WM Course Discriminant Analysis Results for Block Level Data

| Criterion Variables | Bottom 25% Cutoff | Bottom 25% N | Remaining 75% Cutoff | Remaining 75% N | $X^2$ | % Correctly Classified | Order of Predictors |
|---|---|---|---|---|---|---|---|
| Block 2 Time (in minutes) | 451 | 38 | 451 | 106 | 38.0*** | 75.7% | SSQUES<br>CONMGT<br>READCM<br>TSTTAK |
| Block 3 Time (in minutes) | 583 | 38 | 583 | 108 | 1.8 | 55.5% | |
| Block 4 Time (in minutes) | 428 | 36 | 428 | 107 | 5.1* | 59.4% | SSQUES<br>MEMORY<br>READCM<br>CONMGT<br>TSTTAK |
| Block 5 Time (in minutes) | 1603 | 34 | 1603 | 102 | 6.6** | 61.0% | SSQUES<br>TSTTAK<br>READCM<br>CONMGT<br>MEMORY |
| Block 6 Time (in minutes) | 1448 | 32 | 1448 | 94 | 6.2* | 61.1% | SSQUES<br>TSTTAK<br>MEMORY<br>CONMGT<br>READCM |
| Block 7 Time (in minutes) | 624 | 35 | 624 | 106 | 2.1 | 56.0% | |
| Block 8 Time (in minutes) | 1569 | 35 | 1569 | 104 | 18.7** | 68.3% | SSQUES<br>TSTTAK<br>READCM<br>MEMORY<br>CONMGT |
| Block 2-8 Time (in minutes) | 6496 | 13 | 6496 | 61 | 10.6** | 68.9% | READCM<br>SSQUES<br>MEMORY<br>TSTTAK |
| Block 2 Failures | 1 | 258 | 0 | 13 | 36.2*** | 68.3% | MEMORY<br>TSTTAK<br>CONMGT<br>READCM |
| Block 8 Failures | 1 | 129 | 0 | 10 | 26.8*** | 71.9% | READCM<br>TSTTAK<br>SSQUES<br>CONMGT |

TABLE 20 (Continued)

| Criterion Variables | Bottom 25% Cutoff | N | Remaining 75% Cutoff | N | $X^2$ | % Correctly Classified | Order of Predictors |
|---|---|---|---|---|---|---|---|
| Block 2 Score | 72 | 21 | 72 | 125 | 2.7 | 57.8% | READCM<br>TSTTAK<br>MEMORY<br>CONMGT<br>SSQUES |
| Block 8 Score | 71 | 36 | 71 | 110 | 5.4* | 59.6% | TSTTAK<br>SSQUES<br>CONMGT<br>READCM |
| Block 2-8 Score | 545 | 13 | 545 | 62 | 11.2** | 69.3% | READCM<br>MEMORY<br>CONMGT<br>SSQUES |

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 21

WM Course Discriminant Analysis Results for Lesson Level Data

| Criterion Variables | Bottom 25% Cutoff | N | Remaining 75% Cutoff | N | $X^2$ | % Correctly Classified | Order of Predictor |
|---|---|---|---|---|---|---|---|
| Block 2 | | | | | | | |
| Lesson Time | 422 | 68 | 422 | 199 | 13.0* | 61.0% | SSQUES<br>CONMGT<br>READCM<br>MEMORY<br>TSTTAK |
| Lesson Score | 151 | 59 | 151 | 222 | 2.6 | 54.8% | SSQUES<br>MEMORY<br>CONMGT<br>TSTTAK<br>READCM |
| Block 8 | | | | | | | |
| Lesson Time | 602 | 28 | 602 | 82 | 14.6* | 68.2% | SSQUES<br>TSTTAK<br>READCM<br>CONMGT |
| Lesson Score | 307 | 36 | 307 | 109 | 3.7 | 57.9% | TSTTAK<br>READCM<br>CONMGT<br>MEMORY<br>SSQUES |

* $p < .01$