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Prediction of Student Academic Performance with Psychological Constructs beyond Academic Skills

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ABSTRACT

Two separate stepwise multiple regression models were applied to two groups of students in two different departments to predict their academic performance with psychological constructs and domain-specific attributes. The results indicated that prediction of academic achievement requires more proficiency in domain-specific skills. The results also reflected the fact that one model might be more suitable for some students; whereas, the other model or a combination of both models may be more appropriate for other students.

***Key Words*:** stepwise multiple regression model, domain-specific skills, deficit model, interference model

用心理變數預測學生未來之學習成果

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摘　要

用心理變數及學科能力變數藉逐階複回歸預測兩個不同主修科系學生的統計科學期成績。結果顯示學習者未來主修的學科領域與他們主修科系有關的學習課目（定義域範圍）有著密切的關係。學習結果更顯示兩種不同複回歸模式對不同學習背景的學習者有不同的意義。

關鍵詞：逐階複回歸，定義域能力，缺陷模式，干擾模式

I. INTRODUCTION

Studies on students' academic performance have been a great concern in academics of higher learning. The use of Psychological attribute such as test anxiety as predictor of test performance are numerous in literature. Hembree (1988) and Seipp (1991) showed that test in most studies test anxiety is accompanied by lower test performance.

It should be noted that test anxiety of brief episodes of moderate extent to which is a normal part of life for most people. For others, anxiety is so intense, long standing, or disruptive to their daily lives that it is called an anxiety disorder. In the test anxiety literature, the detrimental effect of test anxiety is almost exclusively reviewed within the so-called interference model (Sarason, 1988).

The premise upon which the model argued is that those students as the ones who know the material but "Freezes up" during the examination, are unable to recall prior learning. On the basis of Wine's interference model, students under stress of high level of test anxiety are likely to divide their attention task demands and personal concerns mostly composed of not positive self-preoccupation, whereas those with low level of anxiety tend to devote a greater proportion of their attention to task demands. Kirland and Hollandsworth (1980) have utilized systematic desensitation and relaxation techniques as major treatment approach to reduce test anxiety. It is unfaturate that their anxiety-reduction techniques alone seldom improve performance, whereas combined treatments focused on both test anxiety and skill levels usually did (Allen, Elias, and Zlotlow, 1980). As the interference model seems to be tenable a vast account of research. Subsequent researchers emerged to claim that interference model by no means explains the only preponderance of criterion variables during the test-taking situation. Consequently other variables need to be taken into consideration.

The opponents (Birenbaum and Nasser, 1994) proposed that low performance of highly test-anxious students would exhibit deficit knowledge of inadequate mastery. Other researchers such as Culler and Holahan (1980), Desiderate and Koskinen (1969) all found that highly test-anxious students had less effective study habits than those lower in anxiety. These findings were obviously opposed to the interference model which claims that the highly anxious students who know the subject matter but "Freeze up" at test time. Some proponents of the deficit model even questioned the usefulness of the test anxiety attribute (Kirland and Hollandsworth, 1980; Paulman and Kennelly, 1984).

Some researchers have conceptualized the two models as being mutually exclusive. However, Benjamin, Mckeachine, Lin, and Holinger (1981) conducted studies with evidence showing that one type of test anxious students are those with poor study habits who have difficulties in encoding, organizing and retrieving the information, and that the other type of test anxious students are those with good study habits who have a major problem only in retrieving the information during the examination. The latter type did fairly well in non-threatening situations.

Tobias (1985) rejected the belief that the deficit and interference model as alternative explanations, but conceptualized as being complementary rather than mutually exclusive. Optional performance achieved by those students who have good domain-specific shills and low test anxiety because such students have the greatest proportion of their cognitive capacity available to cope with task demands.

From a theoretical perspective, it is seen that almost all previous studies did separately either on the test anxiety performance for the interference model or on the deficit model, with the majority exclusively focusing on the former one.

There are substantial researches in the past investigating what could be termed with the within theory or monotheortical level of scientific analysis. Very few studies have tried to quantify the research, until recently. Smith, Arnkoff, and Wright (1990) conducted a study relating an introductory psychology course final grade with both test anxiety and academic skills. He found that test anxiety was relatively more important than other variables in the analysis. Bruch, Juster, and Kaflowitz (1983), however, found that in predicting maths test performance ability was the most powerful variable, whereas negative thoughts accounted for only a small portion of the variance. Musch and Bröder (1999) extended the findings of Brusch et al. (1983) and Simth et al. (1990) to include students from non-statistical disciplines who enrolled in a compulsory introductory statistical course. As such, the statistical examination would be assumed to induce more anxiety than do most types of examinations taken by students (Zeidner, 1991). It was also argued that statistical examination is strongly influenced by math ability. Consequently, they assessed the relative contributions of test anxiety, study habits and math skill to statistics performance.

Using hierarchical regression techniques, Musch and Bröder found that maths skills was statistically significant in predicting statistical performance, test anxiety was marginally significant and study habits exhibited no significant effect. Apparently, they tested the difference between what they called the interference model and the deficit model with the results showing that academic skills were relative more important than test anxiety. Their findings were congruent with that of

Brusch et al. (1983) but contradicted to that of Smith et al. (1990).

The study of academic achievement using domain specific skills and psychological constructs is both interesting and challenging. It should be noted that traditional measures of aptitude and intelligence are gathered by testing and therefore, they are possibly confounded with test anxiety. The present study is not intended to compound the issue but simply to include additional variable, self-efficacy, that seems to substantiate the verisimilitude of that of Musch et al. (1999).

II. METHOD

The present study includes students from two majors, one being in the business management and the other being in the industrial engineering. Applied statistics is a compulsory course for both majors. It is believed that statistics performance is strongly related to mathematical ability. So, stepwise multiple regression analysis is used to relate statistics achievement as dependent variable, to math skill, study habits, test-anxiety, and self-efficacy, as independent variables.

1. Participants

One part of the sample consisted of 104 junior students from business management major who took applied statistics at Dayeh University in the spring semester, 2002. The other part of the sample of 79 students was taken from industrial engineering major who also took applied statistics at Dayeh University in the spring semester, 2002. Those who missed the final exam or missed the class in which the data were collected were not counted in the analysis.

2. Procedure

Data were collected about two weeks before the final exam during regular classes. A measure of study habits was administered. The students were also asked for their last math grade earned during high school. Test anxiety and self-efficacy questions were filled out in different questionnaires.

In order to see the difference between the deficit model and the interference model in which how the dependent variable is related to the independent variables, two stepwise multiple regression were performed, which reversed the order of entry of predictor sets.

3. Instruments

A. Test Anxiety - Measure of test anxiety was adopted from the German Version of the Test Anxiety Inventory (TAI-G) (Hodapp, Glanzmann, and Laux, 1995). In order to simplify the administration and ease of understanding, the original four subscales, emotionality, worry, interference, and lack of confidence, had been modified to a measure of state rather than trait anxiety, by using "never happen (1), sometimes (2), often (3), and most often (4), and only total score was used for the purpose of the present investigation (a total of 20 questions, with minimum score of 20 and maximum score 80).

B. Study Habits – The 8-item scale items assessing students' study related behaviors were adopted from Hodapp and Henneberger (1983). Each item asked students to respond on a 5-point scale ranging from 1-completely true to 5-not at all. Low scores included poor study habits. The internal consistency of the scale was of moderate size (α=.44) for business management and (α=.50) for industrial engineering.

C. Math Skills – According to the research reported by Kirland and Hollandsworth (1980) that students were found to report previous grades very accurately. Therefore, students' self-reported last math grade in high school was used as a substitute of mathematics aptitude.

D. Self-Efficacy – Self-efficacy refers to a person's belief that he or she has the ability, motivation, and resources to complete a task successfully. People with high self-efficacy have a can-do attitude toward a specific task and, more generally, toward other challenges in life. One might experience self-efficacy when working in a student support group and form a can-do attitude when another student similar to you describes now he or she was able to perform well in a course you are how taking. There are 10 items in the self-efficacy battery, each of which has 4-point scale ranging from 1-absolutely not to 4-very often. The internal consistency was found to be satisfactory (α=.81) for business management and (α=.89) for industrial engineering.

E. Academic Performance – The criterion variable was the score on the final statistics exam. Because the participants were drawn from two different majors that differed somewhat with respect to course content and final exam questions, test scores were standardized for each of the majors prior to analysis.

III. RESULTS

Table 1 presents the means and standard deviations for all variables. It is noted that the reliabilities for study habits for both majors were lower than that of Musch and Broder reported (α=.77). The difference is perhaps due to cultural differences that affect students' concept pertaining to routine study habits. Brief explanation of the five tests are: a. Exam

Table 1. Means and standard deviations for the variables

	Business Management		Industrial Engineering	
Variable	Means	S.D	Means	S.D
Exam Score [a]	73.48	15.53	60.96	18.21
Math Skill [b]	67.71	12.40	68.41	10.51
Study Habits [c]	3.22	0.45	2.90	0.51
Self-Efficacy [d]	2.79	0.45	2.86	0.52
Test Anxiety [e]	2.15	0.51	2.19	0.48
	N=104		N=79	

Score were Z-standardized for both majors. The score ranges were from 99 to 36 for Business Management, and from 91 to 0 for Industrial Engineering. b. Math Skill was measured by the self-report on last math grade in high school. The highest and lowest scores were 92 and 10 for Business Management, 86 and 15 for Industrial Engineering, respectively. c. Study Habits were measured with 8 items, with α =0.44 for Business Management, and α =0.50 for Industrial Engineering, respectively. The possible range is 8 (worst) to 40 (best). d. Self-Efficacy was measured with a 10-item scale, with α =0.81 for business Management, and α =0.89 for Industrial Engineering, respectively. The possible score range is 10 (lowest) to 40 (highest). e. Test Anxiety was measured with the German version of the Test Anxiety Inventory (TAI-G) (Hodapp et al. 1995), with α =0.90 for both majors. The possible range of total score is 20 (lowest) to 80 (highest).

Separate t-tests were conducted to see the difference between students of the two majors with respect to each variable. As shown in Table 2, the three variables Exam score, Math Skill, and Study Habits were found significant indicating that students of the two majors were different in academic performance on the criterion variable. It also reflects the fact that students of the two different fields were distinctive in background with regard to high school math skill. Their study habits were also dissimilar. The other two variables-Self-Efficacy and Test Anxiety were not found statistically different.

Table 3 shows the intercorrelations among the variables. The small and moderate size correlations in the theoretically expected direction was not so high for multicollinearity to be a serious problem in the subsequent regression analyses.

Stepwise multiple regression was performed, first, with evaluation of whether interference effect of Test Anxiety improved the prediction of exam score beyond academic skill (Math skill, Self-Efficacy, and Study Habits), as would be predicted by the interference model but not the deficit model.

Table 4 shows that, for Business Management, all variables together explained about 20.9% of the variance in the final exam. Math Skill when entered first explained 14.8% of

Table 2. t-test between Business Management and Industrial Engineering for all variables

variable	means	t	p
Exam Score	73.48[+]	5.013	-0.000*
	60.96[++]		
Math Skill	67.71	-11.487	0.000*
	68.41		
Study Habits	3.22	4.417	-0.000*
	2.90		
Self-Efficacy	2.79	-.927	.355
	2.86		
Test Anxiety	2.15	-.513	.609
	2.19		

*p<.05, + The first number of each variable is the mean for Business Management. ++ The second number of each variable is the mean for Industrial Engineering.

Note: N=104 for Business Management, N=79 for Industrial Engineering.

Table 3. Pearson Correlation Coefficients among Text Anxiety, Study Habits, Self-Efficacy, Math skill and Exam Score

Business Management

	1	2	3	4	5
1. Test Anxiety	—				
2. Study Habits	.052	—			
3. self-Efficacy	-.241*	.065	—		
4. Math Skill	-.089	.127	.070	—	
5. Exam Score	.070	.132	-.180	.385**	—

*p<.05, **p<.01, N=104

Industrial Engineering

	1	2	3	4	5
1. Test Anxiety	—				
2. Study Habits	.084	—			
3. self-Efficacy	-.382**	-.040	—		
4. Math Skill	-.074	-.018	.145	—	
5. Exam Score	-.245*	-.080	.130	.444**	—

*p<.05, **p<.01, N=79

the variance and thus contributed significantly to exam performance (p<.01). Self-Efficacy explain about another 4.5% of the variance. Study Habits and Test Anxiety contributed only 1.5% and .1%, respectively, that were not found statistically significant, however.

For the Industrial Engineering majors, all variables accounted for about 24.6% of the variance in the final exam. Math Skill alone explained about 19.7% of the variance and contributed significantly to final exam (p<.01) while Self-Efficacy and Study Habits explained only .5% of the

Table 4. Stepwise multiple regression of exam score in Math Skill, Self-Efficacy, Study Habits, and Test Anxiety

Business Management

Step	Variable	Cumulative R	Cumulative R^2	R^2 change	Beta	t	p
1	Math skill	.385	.148	.148	.396	4.411	.000*
2	Self-Efficacy	.439	.193	.045	-.213	-2.299	.024**
3	Study Habits	.456	.208	.015	.121	1.351	.180
4	Test-Anxiety	.457	.209	.001	.030	.324	.747

*p<.01, **p<.05

Industrial Engineering

Step	Variable	Cumulative R	Cumulative R^2	R^2 change	Beta	t	p
1	Math skill	.444	.197	.197	.430	4.211	0.000*
2	Self-Efficacy	.449	.202	.005	-.017	-.153	.879
3	Study Habits	.455	.207	.005	-.055	-.545	.585
4	Test-Anxiety	.496	.246	.0039	-.215	-1.963	.053**

*p<.01, **p<.06

variance, respectively. Test Anxiety explained about .39% of the variance and was also found statistically significant.

Separate stepwise regression was conducted for both majors to see whether the prediction of exam score is improved when academic skills (Math Skill, Self-Efficacy, and Study Habits) are considered beyond the interfering effects of Test Anxiety, as is suggested by the deficit but not the interference model.

As shown in Table 5, for business management majors, when Test Anxiety was entered first Math Skill alone explained about 30.5% of the variance and contributed significantly to the exam performance (p<.01). Self-Efficacy explained about 3.8% of the variance and was also found statistically significant (p<.05). The other two variables—Test Anxiety and Study Habits were not found to have any additive value for contribution to exam score.

For Industrial Engineering majors, Test Anxiety when entered first was found to explain about 6.0% of the variance and thus contributed significantly to exam performance (p<.06). Math Skill explained about 18.3% of the variance and was also contributed substantially high to exam score (p<.01). The other two variables were found trivial in contribution to exam performance.

V. DISCUSSION

The goal of this study was to compare how well the two models explain academic performance in statistics exam. The findings suggest that, for business majors in the deficit model,

Table 5. Stepwise multiple regression of exam score on Test Anxiety, Math Skill, Self-Efficacy, and Study Habits

Business Management

Step	Variable	Cumulative R	Cumulative R^2	R^2 change	Beta	t	p
1	Test-Anxiety	.070	.005	.005	.030	.324	.747
2	Math skill	.395	.156	.305	.396	4.411	.000*
3	Self-Efficacy	.441	.194	.038	-.213	-2.299	.024**
4	Study Habits	.457	.209	.015	.121	1.351	.180

*p<.01, **p<.05

Industrial Engineering

Step	Variable	Cumulative R	Cumulative R^2	R^2 change	Beta	t	p
1	Test-Anxiety	.245	.060	.060	-.215	-1.963	.053**
2	Math skill	.493	.243	.183	.430	4.211	.000*
3	Self-Efficacy	.493	.243	.000	-.017	-.153	.879
4	Study Habits	.496	.246	.003	-.055	-.545	.588

*p<.01 **p<.06

Math Skill and Self-Efficacy contributed significantly to the prediction of academic performance in statistics exam, whereas Study Habits and Test Anxiety did not. For the Industrial Engineering majors, Math Skill and Test Anxiety were found to contribute statistically significant to exam performance, whereas Self-Efficacy and Study Habits were not.

In the interference model, Math Skill and Self-Efficacy were also found to contribute highly to statistics exam whereas Test Anxiety and Study Habits were not. For the Industrial Engineering students, the same result was found as in the deficit model.

Taken together, the results seem to indicate that Math Skill was relatively more important for both majors in both models because academic performance in statistics exam did require fairly good background in math skill prior to taking the statistics course. The present study is consistent with that Musch et al. (1999) found in their study. Self-Efficacy explained a significant portion of the variance, 4.5% in deficit model and 3.8% in interference model for business management students. It is perhaps these students in social and behavioral sciences who are going to engage in career of business management, having higher belief of expectation for performing a task successfully.

It may be that students in engineering, such as industrial engineering in this study, are more conservative, and are not as convivial as students in the social and behavioral sciences. Therefore, they would be more easily to become susceptible to the attitudes, feelings, or circumstances of stimuli of outside world. Additionally, academic requirements in their fields of study are perhaps more stringent or restrict so that more pressure makes them to have much higher tendency to reveal anxiety.

VI. CONCLUSION AND SUGGESTION

The present study extends that of Musch et al. (1999) by including additional variable, self-efficacy in the business and industrial majors. As seen in the discussion inclusion of the variable did reflect difference in the two groups for the deficit and interference models. More than anything else, the present study selected the two group students whose backgrounds were within quantitative disciplines in which math and statistics are required courses in their chosen fields. It is fair to say that regardless of what students' majors are proficiency in domain-specific skills are truly necessary and requisite for academic achievement. This finding is quite supportive for that of Musch et al., Bruch et al. (1983), and Smith et al. (1990). Moreover, the present study made comparisons of two groups of students with different majors. This extensive comparative studies amplified that of Musch et al. However, further studies might be to look at other variable such as learning style in the two models.

In summary, it is important to note that the present study confirmed the fact that prediction of academic performance requires more proficiency in domain-specific skills. It should also point out that it is a plausible presumption that should be considered in future research that whereas some of the students might best be suited by the deficit model, for other students the interference model or mixture of both models may be more appropriate.

To address the issue of what remedy would be needed to alleviate those test-anxiety prone students generally more thoughts should be given in the direction of school counseling programs that focus on reduction of somatic arousal or modification of worrisome thoughts without skills training or area in which the student is deficient.

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