MATH AND LOGIC SKILLS AS CORRELATES OF TECHNOPHOBIA

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ABSTRACT

This paper, which presents results from a broader project, investigates the role of math and logic skills on technophobia. Data are gathered from 242 subjects at a private university in Western New York. The research hypotheses are tested using multiple regression, t-tests, and correlation analysis. Analysis and interpretation of results is presented. Limitations, delimitations, and potential directions for future research are discussed.

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1.0 Introduction

It is a well-known and well-established fact that basic math skills have shown a remarkable decline in the United States during the last two decades. It is also equally well-established that computer-oriented jobs are increasingly being outsourced to countries in the Asia Pacific region—most notable among them being India and China. Although the issuance of H1B temporary work permits has shown some decline in recent years, the number of H1B visas issued specifically for technology workers have been in the range of 200,000 per year. It is legitimate to wonder whether the erosion of math and logic skills among college students in the United States has played a role in this large-scale outsourcing. This concern is further reinforced by the fact that the National Science Foundation has established a series of grants to investigate the characteristics of technology workers from other countries.

This situation is rather ironic given the all-pervasiveness of computers in US educational delivery systems. Multi-media classrooms with computer-integrated technologies are fast becoming the norm in college campuses. Students are increasingly being required to prepare assignments on

computers and to use computer software and hardware for class projects (Bailey, 2001). The policy of requiring laptops of all incoming freshmen is another trend gathering momentum all over the United States. Yet much of the research on computers in relation to higher education has a distinctive technological focus—-the comparison of traditional instruction with that of computer-aided instructional technology. Role of math and logic skills, though investigated, has been largely limited to perceptual or self-reported measures. The purpose of the present investigation is to explore the role of math and logic skills in technophobia using objective measures.

1.1 Terminology

There is no consensus in the literature on the use of the terms computer anxiety, computer phobia, and technophobia. It would appear that technophobia is a broader attitude applicable toward technology in various forms, and that computer phobia one such instance of technophobia applicable specifically to computer technology. However, such an interpretation, though intuitively appealing, is not consistent with the use of the terms in the literature. Technophobia is a term that has the same specificity toward computer usage as the other two.

Rosen and Weil (1995) define technophobia as "evidence of one or more of the following: (a) anxiety about present or

future interactions with computers or computer-related technology, (b) negative global attitudes about computers and/or (c) specific negative cognitions or self-critical internal dialogs during present computer interactions or when contemplating future computer interaction." Computer phobia refers to negative attitudes about computers (Jay, 1981) whereas computer anxiety refers to the stress due to cognitive as well as psychological factors invoked by the used of computers (Desai & Richards, 1998). Thus, there is a considerable overlap in the use of the terms computer anxiety, computer phobia, and technophobia.

Conceptual frameworks used also exhibit a great deal of variety, ranging from models of organizational change and force field analysis (Desai, 2001) to uses and gratifications model (Finn & Korukonda, 2002). However, for purposes of consistency as well as specificity of operationalization, technophobia as defined by Rosen and Weil (1995) will be used in this paper. The proposed conceptual framework indicating the broader framework within which this work is carried out, is presented in Figure 1.

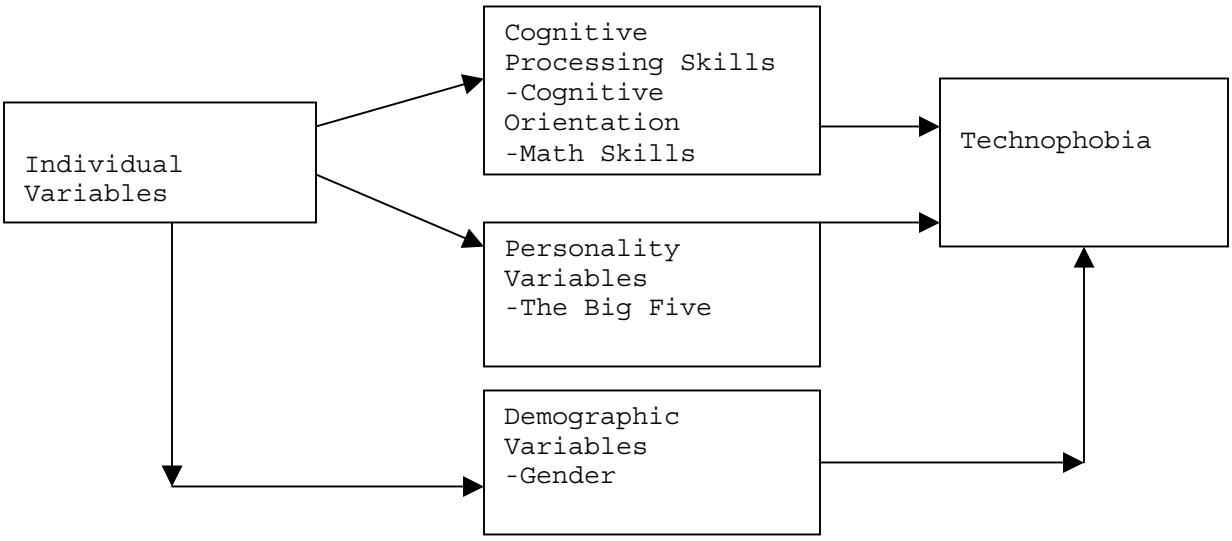

Figure 1: The proposed Conceptual Framework

This paper is restricted to the discussion of the findings concerning

2.0 Development of Research Hypothesis

A number of prior research studies indicate that math anxiety is correlated with technophobia (see, for example, Camber & Cook, 1985, Igbaria & Parasuraman, 1989; Shashaani, 1995). Computer courses place a strong emphasis on mathematical reasoning and consequently, there have been some attempts to explain technophobia in terms of math anxiety (Bandalos & Benson, 1990; Lloyd & Gressard, 1987). However, there are two issues in relation to math skills that are worthy of incorporation into the present research design. Most

of the existing measures of math skills use surrogate measures such as self-reported measures and number of math courses taken. Construct validity of such measures is open to question and a direct measure of math skills such as answers to direct math problems will constitute a definite improvement. Second, advanced math courses, though a part of advanced computer science classes, are not relevant in examining technophobia, which is a phenomenon applicable to the use of computer technology in general and not to computer programming. Development of operating systems with user-friendly interfaces can be expected to reduce the role of math skills. On the other hand, ability to structure a given problem into a form amenable to solution by computers can be expected to result in a higher level of comfort with computers. This leads us to the next set of hypotheses:

Hypothesis: Math and logic skills are inversely related to technophobia.

3.0 Method

The project was conducted during Spring 2002 at a small private university in upstate New York.

3.1 Respondents

The respondents were all full-time students who voluntarily participated in the project. In total, data was gathered from

242 respondents, of whom 119 were female and 123 were male. Thus an almost equal distribution by gender was obtained.

3.2 Instrumentation

The subjects completed a detailed questionnaire consisting of the following parts in sequence. The purpose of administering the descriptive parts of the questionnaire first was to ensure that the subjects' responses are not influenced by any difficulties faced in answering the questions related to the math problems.

Part A: The first part of the survey instrument consisted of biographical information such as age, gender, socio-economic background etc.

Part B: The second part of the survey consisted of questions on self-assessment of math and computer ability, SAT scores, and coursework related to the use of computers. This is followed by questionnaires on technophobia consisting of the following instruments:

(a) Computer Anxiety Rating Scale (CARS-C) developed by Weil, Sears, and Rosen (1988): The items in this questionnaire refer to things and experiences that may cause anxiety or apprehension. The respondents are asked to circle the response that best describes how anxious (nervous) each of these items would make them (Very much to Not at all). Five sample questions are: (i) Thinking about taking a computer language

course (ii) Learning computer terminology (iii) Applying for a job that requires some computer training (iv) Learning to write a computer program (v) Watching a movie about an intelligent computer.

(b) Computer Thoughts Survey (CTS-C) developed by Weil & Rosen (1988): This questionnaire contains items that measure "specific thoughts and cognitions that people have when working with technology or when contemplating working with technology." The respondents are asked to indicate how often they currently have the specified thoughts when they use a computer or think about using a computer (Not at all to very much). Five sample questions are as follows: (a) I am going to make a mistake. (b) This will be fun. (c) Everyone else knows what they are doing. (d) I enjoy learning about this. (e) I like playing on the computer.

(c) General Attitudes toward Computers Scale (GATC-C) developed by Sears, Rosen & Weil (1988): This measures a variety of attitudes toward computers and technology on a five point scale. The subjects are asked to respond on a scale of 1 to 5 (Strongly Agree to Strongly Disagree). Five sample questions are given below: (a) Computers can save people a lot of work. (b) It takes a good math background to learn to use a computer. (c) You need to know how to use a computer to get a

good job. (d) Computers can help solve society's problems. (e) Computers are taking over.

Part C: The last part, consisted of 8 numerical problems to objectively verify the respondent's math skills.

3.3 Measures

Following is a summary description of important measures related to the study.

3.3.1 Technophobia

Technophobia was measured as the aggregate of three sub-scales, Computer Anxiety Rating Scale (CARS-C), Computer Thoughts Survey (CTS-C), and General Attitude toward Computers (GATC). Each of the subscales consisted of 20 items, some positive and some negative. All the items were scored by reversing the directionality of the scores such that higher scores indicate a higher level of technophobia.

3.3.2 Math and Logic Abilities

Math and logic abilities were measured by: (a) the number of math problems correctly answered by the respondents (PROBLCOR) (b) SAT Math scores (SATMATH) and (c) SAT Verbal Scores (SATVERB).

4.0 Data Analysis & Testing of Hypothesis

All the instruments used had extensive validity and

reliability established and reliability. An examination of the descriptive statistics and the overall correlation matrix for all the independent variables revealed some significant correlation coefficients; however, none was large enough to immediately suggest concerns about multicollinearity.

The research hypothesis posits an impact of math and logic skills on Technophobia. To test this hypothesis, three measures of math and logic skills are used: (i) Objective logic and math skills as measured the respondents' answers to problems (PROBLCOR) (ii) Performance on SAT verbal section (SATVERB) and (iii) Performance on SAT math sections (SATMATH). Pearson correlations of these three variables with Technophobia are presented in Table 1 below.

Insert Table 1 about here

All the correlations are in the predicted direction and are significant either at .05 or .01 level. Thus the research hypothesis received strong support.

5.0 Limitations and Discussion

5.1 Limitations

This study shares the general limitations caused by the use of ordinal scales as interval scales (Korukonda & Finn, 2003). Generalizability across other ethnic groups and age

groups is restricted due to inherent limitations of the sample. Replication with samples from different countries and different ethnicities will be needed over time to improve the generalizability of the findings. While it is a fact that they do limit the range of potential applicability of the findings, these limitations do not subtract from the value of testing for and understanding the origins of technophobia.

5.2 Discussion

Personality variables, investigated as a part of the larger study and not discussed here, showed a significant role in technophobia. Thus it would appear that this finding would spell lack of much by way of long-term hope for dealing with and intervening in technophobia. This conclusion needs to be moderated by the findings on the hypothesis on math and logic skills. Those results suggest that in addition to the relatively stable dimension of cognitive orientation, math and logic skills do have a significant effect on technophobia. Thus, it can be argued that the effects of predisposition on account of certain personality dimensions can be neutralized by training in and acquisition of math and logic skills.

6.0 Recommendations And Directions For Future Research

This section presents a discussion of the recommendations and suggested directions for future research.

6.1 Recommendations

It is clear that current, objective, and problem-based measures of math and logic skills at any given time are a valid and reliable measure. This is supported by the fact that the respondents' math skills as measured by their responses to actual math problems correlated equally significantly with technophobia ($r_{tchpbag\text{-}PROBLCOR} = -.133^{**}$) as the SAT math and verbal scores ($r_{tchpbag\text{-}SATMATH} = -.147^{**}$, $r_{tchpbag\text{-}SATVERB} = -.150^{**}$). This suggests a potential avenue for establishing the currency and construct validity of historical measures such as SAT scores. Though the shortness of the time lag between SAT and the survey instrument for this project could explain the consistency among these measures, it would seem to be a good idea to supplement the personality measures with objective, problem-based measurement of math and logic skills in any diagnostic efforts. On an optimistic note, there are a number of studies to indicate that math anxiety can be alleviated through skills training interventions (Bander, Russell, & Zamostony, 1982).

6.2 Directions for Future Research

This study needs replication across a broader spectrum of ethnic, vocational, and age groups to assess the stability of the relationships found here. Such additional research is needed to examine the role of individual variables in

conjunction with different organizational contexts represented by a more diverse sample than college students from a single source. Such research could also address the issue of restriction of range in terms of age and socioeconomic background that is a byproduct of the convenience nature of the sample.

TABLE 1

PEARSON CORRELATIONS BETWEEN TECHNOPHOBIA AND MATH AND LOGIC SKILLS AS MEASURED BY: (a) PROBLCOR (b) SATMATH (c) SATVERB

	TCHPBAG
TCHPBAG	1.000
PROBLCOR	-.133* ($p_{one\text{-}tailed}$= .020, n= 240)
SATMATH	-.147** ($p_{one\text{-}tailed}$= .012, n= 238)
SATVERB	-.150** ($p_{one\text{-}tailed}$= .013, n= 218)

*Correlation is significant at the .05 level
**Correlation is significant at the .01 level

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