THE DAT AS A PREDICTOR OF SUCCESS IN HIGH SCHOOL MATHEMATICS COURSES AND AN AID IN MATHEMATICS COURSE SELECTION

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ABSTRACT

This is a study of the relative contribution of scores on various tests to the prediction of mathematics (math) marks. Specifically, the following tests were investigated: Differential Aptitude Tests (DAT) Form S subtests Verbal Reasoning (VR), Numerical Ability (NA), composite Verbal Reasoning and Numerical Ability (VR + NA), Space Relations (SR), and Abstract Reasoning (AR); Quick-Scoring Group Test of Learning Capacity: Dominion Tests, Intermediate, Form A (DOM); Henmon-Nelson Tests of Mental Ability, Form A (HN); and Otis Quick Scoring Mental Ability Tests, Alpha, Short Form (OTIS). Math mark was defined as the percentage mark on a final, uniform, cumulative examination for Math 100 and 101, and as the final mark based on the year's work for Math 102.

Sample I consisted of 267 grade ten students of Sisler High School, Winnipeg, that school's total grade ten population with scores available on all variables. Data for each math course were subjected to a stepwise forward inclusive multiple regression analysis with all variables allowed to enter the regression equation freely.

The multiple correlation coefficients between math mark and scores on the variables were: .638, F (7, 127) = 12.422, $p < .001$, for Math 100; .570, F (8, 78) = 4.684, $p < .001$ for Math 101; and .614, F (5, 29) = 3.511, $p < .05$, for Math 102. Sample I was used as a screening device to reduce the number of variables to be

considered to those with correlation coefficients significant at the .05 level. If no variable were to be found significant at that level, the one correlating most highly with math mark would be considered.

The significant variables for Math 100 Sample I were: VR + NA, $\underline{R} = .574$, $\underline{F}\ (1, 126) = 6.058$, $\underline{p} < .05$; and SR, $\underline{R} = .620$, $\underline{F}\ (1, 126) = 12.407$, $\underline{p} < .001$. The significant variable for Math 101 Sample I was NA, $\underline{R} = .495$, $\underline{F}\ (1, 78) = 4.605$, $\underline{p} < .05$. No variable was found to be sufficiently significant for Math 102. NA, which correlated most highly with Math 102 mark, was therefore chosen for Math 102 Sample II.

Sample II consisted of 344 Sisler students with scores available on VR + NA and SR for Math 100 and NA for Math 101 and Math 102. Data for each math course, females only, males only, and total sample were subjected to stepwise forward inclusive multiple regression analyses with variables allowed to enter the regression equation freely ($\underline{p} < .01$).

The multiple correlation coefficient between Math 100 mark and scores on VR + NA and SR was .616, $\underline{F}\ (2, 159) = 48.670$, $\underline{p} < .001$ for total sample. The correlation coefficients between math mark and score on NA were: .473, $\underline{F}\ (1, 130) = 37.490$, $\underline{p} < .001$ for Math 101 total sample; and .519, $\underline{F}\ (1, 48) = 17.705$, $\underline{p} < .001$ for Math 102 total sample. The differences between correlation coefficients computed for females and males were not found to be statistically significant. Regression equations were derived to predict math marks for Math 100, 101 and 102. Tables were constructed so that students in grade nine could see the success or failure in math courses of previous students with similar DAT scores.

Although other factors, such as goals, values, motivation, and background, must be considered in math course selection, it is suggested that these be considered in addition to rather than in lieu of DAT scores. The research conducted in this study indicates that, of all test scores available to Winnipeg educators, DAT scores, specifically VR + NA, SR, and NA, contribute most to prediction of success in math and thus aid math course selection.

CHAPTER I

INTRODUCTION TO THE STUDY

Background and Purpose of the Study

The Differential Aptitude Test (DAT) was administered to all grade nine students in Winnipeg School Division #1 from 1963 to 1972. In 1972, when the school division discontinued the position of a Guidance Coordinator, individual school counsellors were suddenly faced with having to decide whether or not to continue administration of the DAT to their junior-high students. A few counsellors decided not to administer it. Their reasons given usually consisted of statements beginning with, "I think." Opposing arguments in favour of retaining the DAT were often equally unscientific and also began with, "I think." This type of reasoning, of course, left the issue unresolved. Those who favoured the use of the DAT and who argued with, "Researchers state . . . ," were countered with, "But now . . . ," or, "But here . . . ," leaving the issue still unresolved.

If the DAT is not a useful tool in helping students to choose courses, mathematics in particular, then many counsellors are wasting a great deal of time. For instance, counsellors at Sisler High School, the locale of this study, not only spend several class periods explaining the use and relevency of the DAT, and several class periods interpreting the DAT generally, but they also spend approximately 20 minutes with each student interpreting scores and discussing

course selection for the following year. If, on the other hand, the DAT is a useful tool, what a great disservice is being done to students who are not given the opportunity to benefit from such scores when choosing their courses.

During numerous debates on usefulness of test scores, the author has expressed the "thought" that DAT scores, in particular those from Numerical Ability and Space Relations subtests, are useful as a predictor of level of success in various mathematics courses and therefore as an aid in mathematics course selection. Opponents in the continuing debate counter with the "thought" that they are not useful. This type of debate might best be settled by objective analysis. The author proposes in this study to determine the extent to which various DAT subtest scores, as well as scores from three additional tests: Dominion, Henmon-Nelson, and Otis, predict mathematics marks of grade ten students at Sisler High School.

Problems in Course Selection

A grade nine student faces the problem of choosing, wisely, a grade ten mathematics course which is most appropriate to his needs and abilities. However, three main factors contributing to the problem are flexibility, standards, and policy regarding failure.

Flexibility

Flexibility, a recent characteristic of most high schools, offers many advantages to students. Because of flexibility, however, students face problems in course selection which were not encountered a generation ago.

Formerly, a grade nine student's only option on entering grade

ten was whether or not to take French and/or Latin. This choice often was made by teachers without student participation in the decision. Today, students must choose from five different mathematics courses at the grade ten level. The courses are designed to provide prerequisite knowledge for a student to be eligible to continue in that program of mathematics or any easier program in grade eleven. The student cannot choose a more difficult program of mathematics in grade eleven. For example, a student with standing in grade ten Mathematics 100 may choose from the following courses listed in descending order of difficulty, Mathematics 200, 201, 202, 203, or 204. A student with standing in Mathematics 102, however, may choose only Mathematics 202, 203, or 204. One's choice of mathematics course can restrict one's choices, not only for subsequent mathematics courses, but for related courses, postsecondary programs, and, eventually, careers. It seems crucial that each student choose the best possible grade ten mathematics course. Too difficult a program might lead to failure, whereas too easy a program might lead to unnecessary future restrictions.

In an attempt to be flexible, many schools now offer as many as 114 different options for high school students. Ironically, this very flexibility has resulted in more rigid timetabling for students. Change from one program of mathematics to another, should an incorrect course choice have been made, may lead to a change of teachers for all other courses. These changes may impose an undue hardship on the student, because different teachers may use not only different methods but also different texts, perhaps with different content. Thus, the student may be considerably disadvantaged, if he were unable to make correct grade ten course choices while in grade nine.

Standards

Many of the controls which once served to help teachers set standards have disappeared.

In the past, grade nine marks were considered good predictors of success in high school. Today, though, standards vary among areas of the city, among schools, and among teachers. The disparity of these standards has increased drastically because of a number of factors.

Uniform examinations at the grade nine level were written in Winnipeg until 1970. This practice meant that all Winnipeg students in any given course wrote the same examination and were able to compare their scores to those of others. Today, many schools do not administer uniform examinations. Others do not use examinations at all. Also, some have switched from percentage grades to letter grades, while others have switched from letter grades to "pass" or "fail" and, in some schools, passing seems to be determined by attendance or personality.

A standard curriculum once existed in Winnipeg. Concepts to be developed in each course were listed, and copies of the lists were distributed to each teacher. Today, a curriculum guide exists, but is set forth only as a guideline to be interpreted to the letter or loosely, or to be totally ignored. Whereas experienced teachers may appreciate the freedom to develop their courses, new teachers may find that the lack of standards in course content is confusing.

Various "schools of thought" regarding aims of education have led junior high schools to set varying standards. One school may state that, to pass grade nine, the student has to master specific

concepts which are prerequisite for grade ten programs. Another school may favour community involvement to such an extent that it freely admits to having "passed" grade nine students who, on a standardized test, functioned at a grade five or six level. Both may send their students to the same high school.

The confusion over standards among schools may also be increased by the continual emergence of new programs in Winnipeg schools. For example, at Sisler High School, a grade nine student in level Beta Four[1] with a mathematics mark of "A" would probably be capable of doing the same level of mathematics as a grade nine student in level Alpha One[2] with a mathematics mark of "E". As a counsellor at Sisler, the author is cognizant of these standards and their implications, but would counsellors from other schools assess accurately the mathematics ability and knowledge of students transferring from Sisler to their schools?

The problem of different standards is magnified by the fact that society as a whole has become extremely mobile. Because moving from one school to another may mean changing from one set of standards to another, a student's marks may not provide a good basis for course selection at the new school.

Parental advice on course selection is often not forthcoming because parents find today's high schools so drastically different from those they attended. The judgement of the parents who do try to contribute may be biased by the standards underlying the marks the student has been given in the past.

School Inspectors were discontinued in Winnipeg as of 1970. Previous to that date, teams of these qualified, experienced educators

travelled from school to school evaluating the educational process and helping teachers to maintain specific and consistent standards. Principals and teachers were able to learn how their standards compared with those of other Winnipeg schools. In contrast, at present teachers and their standards are evaluated by a principal (who may or may not have any training or competency in particular subject areas), by co-workers (who may or may not be aware of what is happening in other schools), by students (who may merely be rating personality), or by some other method. The choice of evaluative method is that of each individual school.

A reorganization of the school division into areas in 1975 meant that teachers had less opportunity to meet and compare standards with those still in the same division but who now worked in other areas.

The aforementioned changes have made it very difficult, if not impossible, for some students to judge their abilities and knowledge in particular subject areas. As a result, it is increasingly difficult for students, teachers, or counsellors to assess student competency in mathematics, and then make wise choices of grade ten mathematics courses.

Policy Regarding Failure

School board policy in Winnipeg has been "against failing." Perhaps this means that students will be taught for mastery, that is, students would master each concept in a course before going on to the next. Although individual students might take different lengths of time to complete courses, or grades, all would master subject material and eventually "pass." Unfortunately, the result of this policy has not been universal teaching for mastery. The practice often followed is that all students proceed from one concept, chapter, grade, and

school to the next at the same time, whether they completed the prerequisite work or not. In other words, by refusing to retain students, educators may be guaranteeing future failure for some. Students are "passed" into courses for which they may not have the basic skills, because educators have not insisted that they first master the basic prerequisites.

Because of this policy and its ramifications, such as the trend away from Special Education classes, mathematics teachers have had to develop new courses for grade ten students who could not cope with existing programs. However, these courses benefit students only if they correctly choose them. Unfortunately, some students lacking basic skills were always "passed" in mathematics and, based on this assessment, sometimes the only information they had received on their mathematical ability from educators, they tend to overestimate their ability and knowledge. They may choose the most difficult of the grade ten mathematics courses. Although students have the freedom to change courses, the change may come too late. They may be transferring to courses which they could have handled, had they been in them from the beginning of the course. Starting a month or two behind other students in the course may lead to failure. The time factor is considerably more important in a semestered school.

Significance of the Study

Students face ever increasing difficulties in mathematics course selection. Factors such as interests, motivation, past performance, and goals should all be considered, but the aptitude of the student for mathematics is a factor which must be taken into account, although this is often an unknown factor, more so today than ever before.

Some counsellors who do use the DAT as an aid in mathematics course selection do so intuitively, simply by "eyeballing" DAT scores and making educated guesses. This, however, is a most difficult skill to pass on to others.

Tools are needed to help students make their choices easily and wisely. The DAT is therefore being proposed and investigated in this study as such a tool. Because many Winnipeg counsellors now have the responsibility for deciding whether or not to use the DAT, this study could have significance to them. It could also have significance for counsellors outside of Winnipeg, to students, to parents, and to educators generally.

CHAPTER II

REVIEW OF RELATED LITERATURE

The Use of Standardized Tests in Educational Prediction

Current literature (Bedal, 1976; Mussio, 1976) indicates that, unless the public drastically changes its mind about standards and accountability, educators will undoubtedly be seeing more tests of one kind or another in schools. Along with the tests, educators will be facing the problems inherent in any testing program.

Criticisms Concerning Test Development

Some criticisms aimed at standardized tests have been concerned with test development and are specific to each particular test. General criticisms in this area concern reliability, validity, norms, and revisions. An unreliable test gives inconsistent results. An invalid test does not measure what the test purports to measure. The norms may or may not be relevant to the person being tested. A revision may or may not be equivalent to the original in those areas assumed to be equivalent.

Criticisms Concerning Test Administration

Other criticisms aimed at standardized tests have been concerned with the administration of the tests. Variables which have come under attack are competence of examiners, timing, clarity of directions, physical setting, guessing, pretest orientation, machine accuracy, and format of answer sheets.

The competence of the examiners may vary significantly. An examiner unfamiliar with testing or instructions for a particular test may inadvertently invalidate the results. Obviously, inaccurate timing, unclear directions, or lack of direction regarding guessing may distort the results of any test.

Physical setting consists of a variety of factors such as lighting, size of group, familiarity of surroundings, time of day, day of week, temperature, noise level, and physical comfort. Each of these factors, in some circumstances, has the potential to lower students' scores.

Researchers have extensively investigated the aspect of guessing. Cronbach's research (1942) indicates a tendency toward choosing the true response in true-false questions. The research of Rapaport and Berg (1955) indicates a tendency toward choosing alternatives located in a middle position with multiple choice items. These tendencies are elicited by the relatively difficult test items. Stricker's research (1965) shows that the later an item appears in a test, the more susceptible it is to these tendencies.

Information on pretest orientation is given in very few research studies. Jacobson's (1975) research stresses the importance of the pretest orientation. There is a vast difference between a student's "hearing" that a test and its results are important and relevant to him and a student's "believing" that the test and its results are important and relevant. The difference is reflected in the student's effort and corresponding score. Test anxiety has been found to correlate negatively with aptitude test scores (Grooms & Endler, 1960; Walter, Denzler, & Sarason, 1964). Perhaps a thorough pretest

orientation might reduce test anxiety.

A problem common to all machine-scored answer sheets is the lack of accuracy of the marks made by students on the answer sheets. Durost (1954) reported that it was necessary to erase or darken marks on from 10 to 50% of the student-marked answer sheets before they could be put through an IBM 805. Burack (1961) reported that when Strong Vocational Interest Blanks answer sheets were rescored by the same agency, 96% of the sheets showed change. More recent studies (Merwin, Bradley, Johnson, & John, 1965; Spencer, 1966; Weigel, Roehlke, & Poe, 1965) suggest that errors are few and those that do exist are seldom large enough to affect profile interpretation. Womer (1969) found that in a comparison between hand and machine scoring, machines made no errors, whereas the human hand made 11.

More important than the problem of machine accuracy is the problem of answer-sheet format. The Differential Aptitude Tests manual (Bennett, Seashore, & Wesman, 1966) presents different norms for the Clerical Speed and Accuracy Test for IBM 805, MRC, IBM 1230, and Digitek answer sheets. A study of different answer sheets available for use with the General Aptitude Test Battery showed significant differences between the different types of sheets (Bell & Hoft, 1964). Research indicates that examiners must not use an answer medium different from the one on which a test has been standardized without evidence of the comparability of norms.

Criticisms Concerning Use of Test Results

Most criticisms aimed at standardized tests have been concerned with how the results have been or may be used. Many people fear that test results have been or may be used: to exclude students from