INFLUENCE OF ATTITUDE TOWARDS STATISTICS, ENGLISH LANGUAGE ABILITY AND MATHEMATICAL ABILITY IN THE SUBJECT QUANTITATIVE TECHNIQUES AT THE VAAL TRIANGLE TECHNIKON, SOUTH AFRICA ®

Verena Nolan
Vaal Triangle Technikon
South Africa

This project was a quasi-experiment designed to investigate whether three factors influence student performance in Quantitative Techniques: (a) the attitude of students towards Quantitative Techniques as a service subject, (b) English language ability of students, and (c) Mathematical ability of students. The results show deficiencies in students' competencies with respect to both language and mathematical ability. The overall impression of the students is that their mathematical ability is the major problem.

INTRODUCTION

Quantitative Techniques is a service subject offered at the Vaal Triangle Technikon to students enrolled for three diplomas: Cost and Management Accounting, Human Resource Management and Marketing. The overall pass rate of students in Quantitative Techniques is of great concern to the facilitators of the subject. The average overall pass rate over the past four years was as follows: 1997 – 54%; 1998 – 51%; 1999 – 53% and 2000 – 36%.

Many factors may be responsible for the poor performance of students in Quantitative Techniques. Various studies have focused on factors contributing to success in statistical courses (Agar, 1990; Buthelezi, 1995; Elmore & Vasu, 1980, 1986; Gal & Ginsburg, 1994; Hudak & Anderson, 1990; Miller et al., 1998; Onwuegbuzie et al., 1997; Secada, 1996, Verhoef, 2001). Some of these predictors are spatial ability, anxiety, gender, learning styles, social factors, age, under-preparedness, attitude, language ability, mathematical ability, tertiary environment and students' academic background.

A quasi-experiment was conducted with students enrolled in 2001 for Quantitative Techniques to investigate whether the following three factors have an influence on the poor performance in this subject: (a) the *attitude of students towards Quantitative Techniques* as a service subject, (b) *English language ability* of students and (c) *Mathematical ability* of students. The researcher chose these factors because she believes that these issues could explain the poor performance of students in Quantitative Techniques.

RESEARCH METHODOLOGY

For the first factor, the Attitude Towards Statistics (ATS) questionnaire compiled by Wise (1985) was used. For the other two factors, two specialized questionnaires were designed. The questionnaire for the English language ability tests the students' understanding of eight specific statistical terms in English. The questionnaire for mathematical ability tests the students' understanding of six basic mathematical concepts. The researcher decided to focus on the eight statistical terms and on the six mathematical concepts because her observations in the Quantitative Techniques class indicated that the students experienced problems with these terms / concepts.

A convenience sample of students that were enrolled for Quantitative Techniques at the Vaal Triangle Technikon in the second semester of 2001 was selected. The sample comprises the students that attended the Quantitative Techniques class on the day that the lecturer handed out the questionnaire. The questionnaire for each factor was handed out on different days, therefore the sample size for each factor is different. Table 1 presents the sample sizes, per diploma, for students that completed each of the three questionnaires. The questionnaires of students that were not enrolled for any one of the three diplomas *or* who did not indicate the diploma for which they are currently enrolled were excluded from the analysis.

Table 1
Sample Sizes Of Completed Questionnaires

Sample size	Cost and Management Accounting	Human Resource Management	Marketing	TOTAL
a) Attitude towards statistics	190	43	129	362
b) English language ability	261	68	138	467
c) Mathematical ability	251	64	173	488

ATTITUDE TOWARDS STATISTICS

The *main objective* was to determine the students' attitude towards Quantitative Techniques as a service subject. As Gal and Ginsburg (1994:14) comment: "to make the learning of statistics less frustrating, less fearful, and more effective, further attention … should be focused on beliefs, attitudes, and expectations students bring into statistics classrooms".

The Attitude Towards Statistics (ATS) questionnaire compiled by Wise (1985) was used. This questionnaire consists of two subscales: Attitude Toward the Field of Statistics (9 questions) and Attitude Towards the Statistics Course (20 questions). The Field subscale is intended to measure students' attitudes towards the use of statistics in their chosen field of study. For example, I feel that statistics will be useful to me in my job. The Course subscale is intended to measure student's attitudes towards the statistics course itself. For example, the thought of being enrolled in a statistics course makes me nervous (reverse scored). ATS anchors are "Strongly Agree" (coded 1) and "Strongly disagree" (coded 5). Therefore, a low score indicates a more positive attitude.

Table 2
Statistical Results on the ATS Questionnaire, per Subscale

Statistical results	Cost and Management Accounting		Human Resource Management		Marketing	
	Field subscale	*Course subscale*	*Field subscale*	*Course subscale*	*Field subscale*	*Course subscale*
a) Correlation	-0.308** (n=121)	-0.314** (n=121)	-0.245 (n=37)	-0.358* (n=37)	-0.301** (n=100)	-0.381** (n=100)
b) Item means	2.2897	2.4573	2.3872	2.7804	2.3585	2.7330
c) Alpha	0.6893	0.8067	0.8488	0.9016	0.8719	0.8939

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 2 presents three findings:

(a) The correlation of the students' attitude with the final mark obtained in semester 1. The sample size in this table indicates the number of respondents that completed the questionnaire and indicated their semester 1 mark. These results show a significant correlation with the Field subscale and the Course subscale, for the Cost and Management Accounting students and Marketing students. For the Human Resource Management students only the Course subscale showed a significant correlation. One of the reasons for this could be related to the low response rate of the Human Resource Management students, although Wise (1985:404) also found a significant correlation on the Course subscale but not on the Field subscale.

(b) The item means. In general, the students' attitudes towards the *field* of statistics tend to be *positive*, whereas attitudes towards the statistics *course* tend to be *neutral*. (The scale value 3 is neutral.)

(c) The coefficient alpha estimates the reliability of the student attitudes. All internal consistency reliability estimates were judged to be satisfactory. These alpha values are

comparable to those other researchers have found in the use of these scales and subscales, where approximately 0.7 is acceptable (Kottke, 2000; Shultz & Koshino, 1998; Wise, 1985).

ENGLISH LANGUAGE ABILITY

The *main objective* was to determine if the students understand specific statistical terms in English (for example: *at least, sketch* and *describe*). At the Vaal Triangle Technikon students study through the medium of English, although 97% indicated that English is not their mother tongue. Researchers, in general, have observed a low level of English second language proficiency among South African students (Buthelezi, 1995; Coetzee-Van Rooy & Verhoef, 2000; Verhoef, 2001).

A typical question from the questionnaire to test the students' understanding of statistical terms is:

- Seven runners clocked the following times (in minutes) over a route run in training.

  4.7 5.0 4.8 5.1 9.0 4.3 4.2

  Answer: Average = Sum of data / number of students = 37.1/7 = 5.3

  Was this answer (a) Calculated (b) Estimated

Table 3 presents the statistical terms together with the percentage of students that *correctly* answered the question on these terms, per diploma. The incorrect answers and the students who did not complete a specific question contribute to the rest of the percentage.

Table 3

Percentage of Students that Correctly Answered Questions Involving Statistical Terms, per Diploma

Statistical terms	Cost and Management Accounting	Human Resource Management	Marketing
At least	*7 %*	*12 %*	*9 %*
At most	*4 %*	*7 %*	*8 %*
Sketch	64 %	*47 %*	72 %
Construct	66 %	66 %	67 %
Name	74 %	*43 %*	75 %
Describe	83 %	75 %	80 %
Calculate	84 %	69 %	75 %
Estimate	77 %	60 %	70 %
Average	57,4 %	47,4 %	57 %

Understanding of the statistical terms *at least* and *at most* appears to be problematic. The percentage of students who answered these two questions correctly is extremely low for all three diplomas. In general, the remaining terms: *sketch, construct, name, describe, calculate* and *estimate* are well understood by the students, although *sketch* and *name* reflect lower levels of understanding by the Human Resource Management students.

The *secondary objective* was to identify the perception of the students of the language used in their prescribed textbook in Quantitative Techniques. The textbook used is one of the more elementary Statistics textbooks available on the market. The author is a South African and does not use British or American English or examples. The textbook is straightforward and to the point, but assumes that students are able to perform basic mathematical calculations.

The relevant question in the questionnaire was:

- Are the formulations and explanations in the prescribed textbook understandable?

Yes	No

If *No*, what do you not understand in the textbook?

English language	Mathematical calculations/concepts	Other

Out of the total of 467 students, 179 students (38%) indicated that the formulations and explanations in the textbook are *not* understandable. Out of these 179 students, 19 students (11%)

indicated English language, 129 students (72%) indicated mathematical calculations/concepts, 8 students (4%) indicated Other. The remaining percentage (13%) comprises combinations of reasons or non-response. From these results it is clear that the students do not perceive their understanding of the English formulations and explanations to be a problem. There could be two reasons for this:

(a) According to Barkhuizen (1995:116) the students are "probably familiar with the particular subject exams of the examination body which sets the paper, familiar with the format of the paper, with the linguistic style of asking questions and more specifically, with the actual words and syntactic structures used in the questions." This *could* be true for this study, because the students had already attended semester 1 of Quantitative Techniques before this study was conducted.

(b) Coetzee-Van Rooy and Verhoef (2000:182) comment "when the respondents evaluate their proficiency in English, they might have its role as lingua franca uppermost in their minds, and not its role as medium of instruction that requires literacy-related academic language proficiency". This *could* indicate that the students perceive their English language ability as high/good/no problem (as in this study), although as mentioned earlier, researchers in general observe low levels of English second language proficiency among South Africans.

MATHEMATICAL ABILITY

The *main objective* was to determine if the students understand basic mathematical concepts used in Quantitative Techniques (for example: *percentages, square root* and *less-than*). According to Miller and Bradbury. (1998:105) "basic competence in mathematics is an essential aspect of preparedness for most tertiary courses". The majority of students that was enrolled for Quantitative Techniques in 2001 had Mathematics as one of their Grade 12 subject (80% - Cost and Management Accounting students; 63% - Human Resource Management students; 56% - Marketing students).

A typical mathematical concept question used in the questionnaire was:

- The square root of 25 is:

  (a) 625 (b) 50 (c) 5 (d) 12,5

  Would you have been able to correctly answer this question before you enrolled for Quantitative Techniques?

Yes	No

The first part of the question requires the actual calculation of the mathematical concepts and the second part of the question reflects the student's perception of his/her understanding of each mathematical concept. A problem that was encountered was that if a student answered *no* to the second part of the question, they did not always complete the answer for the mathematical concept. There could be two reasons for this: (a) either they misunderstood the question and did not know what was expected from them or (b) they really did not know the answer.

Table 4 presents the mathematical concepts together with, (a) the percentage of students that answered the question on these concepts correctly, per diploma and, (b) the responses to the question: 'Would you have been able to answer this question before you enrolled for quantitative techniques?' In this table, only the *correctly answered* questions and the *positive perceptions* of the students are reflected. The incorrect answers, the negative perceptions and the students who did not complete a specific question contribute to the rest of the percentage.

Calculation of the mathematical concept correctly (first entry in Table 4) indicates that the two mathematical concepts: *solving the unknown* and *percentages* should be regarded as problem areas. The percentage of students who answered these two questions correctly is very low. Although the percentage of students who answered the questions about mathematical concept: *more-than / less-than* correctly is close to average, it *could* suggest another problem area for some students.

Table 4
Per diploma: Percentage of students who answered the mathematical concepts questions correctly (first entry) and who held positive perceptions (expressed in percentage) of their understanding of these mathematical concepts (second entry)

Mathematical concepts	Cost and Management Accounting		Human Resource Management		Marketing	
	Concept correct	*Positive perception*	*Concept correct*	*Positive perception*	*Concept correct*	*Positive perception*
Square root	81 %	95 %	69 %	80 %	73 %	86 %
Hierarchy of Operations	87 %	83 %	75 %	*63 %*	71 %	*65 %*
Substitution into formula	88 %	86 %	78 %	72 %	76 %	68 %
Solving the Unknown	*37 %*	*63 %*	*25 %*	*50 %*	*28 %*	*51 %*
Percentages	*41 %*	*53 %*	*34 %*	*48 %*	*36 %*	*53 %*
More-than / Less-than	*59 %*	*59 %*	*63 %*	*59 %*	*60 %*	*61 %*
Average	65,5	73,2 %	57,3 %	62 %	57,3%	64 %

The students' *positive perceptions* of their understanding of these mathematical concepts (second entry) reflects that the students perceive their understanding of the first three mathematical concepts as relatively effective, although the mathematical concept, *hierarchy of operations* for the Human Resource Management students and Marketing students is very close to the average. This indicates that *some* students have a problem with the *hierarchy of operations* concept, but in general the students feel that they understand and they feel confident to solve problems involving the first three mathematical concepts or use these mathematical concepts in calculations. The percentages of the students' perceptions on the last three mathematical concepts are below average, which indicates that only *some* students feel confident about their understanding and use of these concepts.

In general, if the calculation of the mathematical concepts (first entry in Table 4) is compared to the students' perceptions (second entry in Table 4) it is observed that the students' perceptions and the actual calculation of the concepts differ. For the two mathematical concepts, *solving the unknown* and *percentages*, the students have a more positive perception of their understanding than their actual calculations indicate. In Cost and Management Accounting, 63% of students believe that they can *solve the unknown* and 53% of them believe they understand how to work with *percentages*, but only 37% and 41% respectively could correctly perform the applicable calculations. The same interpretation applies to the other two diplomas.

From this questionnaire it appears as if the students struggle to understand the mathematical concepts: *solving the unknown* and *percentages*. The concepts *more-than / less-than* also cause problems to a lesser extent for some students. The *square root*, *hierarchy of operations* and *substitution into formula* are well understood by the students.

CONCLUSIONS

This project investigated whether there is evidence to believe that three particular factors influence student results in Quantitative Techniques. For the three factors under consideration, the following conclusions are reported:

1. Attitudes towards the *field* of statistics tend to be *positive*, whereas attitudes towards the statistics *course* tend to be *neutral*.
2. The students have a good degree of understanding of the terms *sketch, construct, name, describe, calculate* and *estimate* but their understanding of the terms: *at least* and *at most* needs to improve. According to the students' perception of their prescribed textbook in Quantitative Techniques, they do not perceive the understanding of the English

formulations and explanations (except for the terminology commonly used in Probability) as their main concern. They regard their mathematical skills/ability as problematic.

3. The three mathematical concepts *square root*, *hierarchy of operations* and *substitution into formula* are well understood by the students, whereas their understanding of the concepts *solving the unknown*; *percentages* and *more-than / less-than* needs to improve. These 'problem' mathematical concepts related to the Probability section.

These results show various deficiencies in students' competencies. Although the neutral attitude of the students towards Quantitative Techniques and the students' perception of their English language ability are of concern to the researcher, the overall impression of the students is that their mathematical ability is the problem. According to Secada (1996:430) "research and evaluation involving bilingual education programs have been driven by concerns for the development of English and of academic subject matter among students requiring English. These studies have taken for granted the school mathematics curriculum that students are exposed to and, even when problems in instruction are noted, those concerns get cast in terms of language development".

Future studies will

(a) address the connection between individuals' attitudes, language ability and mathematical ability with their results in Quantitative Techniques; and

(b) draw a comparison between a pre-test and post-test to ascertain whether the improved mathematical competencies influence the pass rate in Quantitative Techniques.

REFERENCES

Agar, D. (1990). Non-traditional students: perception of problems which influence academic success. *Higher Education*, 19:435-454.

Barkhuizen, G. (1995). Setting examinations: implications for English second language speakers. *Journal of Language Teaching*, *29*(2): 110-136.

Buthelezi, Q. (1995). Black South African English. In R. Mesthrie (Ed.), *Language and social history: Studies in southern african sociolinguistics* (pp.242-250). Cape Town: David Phillips.

Coetzee-Van Rooy, A.S., & Verhoef, M.M. (2000). Perception of English proficiency: views from Southern Sotho speakers. *South African Journal of Linguistics*, (Suppll.), *38*, 165-187.

Elmore, P.B., & Vasu, E.S. (1980). Relationship between selected variables and statistics achievement: Building a theoretical model. J*ournal of Educational Psychology*, *72*, 457-467.

Elmore, P.B., & Vasu, E.S. (1986). A model of statistical achievement using spatial ability, feminist attitudes and mathematics-related variables as predictors. *Educational and Psychological Measurement, 46,* 215-222.

Gal, I., & Ginsburg, L. (1994). The role of beliefs and attitudes in learning statistics: Towards an assessment framework. *Journal of Statistical Education, 2*(2), 1-16.

Hudak, M.A., & Anderson, D.E. (1990). Formal operations and learning styles predict success in statistics and computer science courses. *Teaching of Psychology*, *17(4*), 231-234.

Kottke, J.L. (2000). Mathematical proficiency, statistics knowledge, attitude toward statistics, and measurement course performance. *College Student Journal*, *34(3),* 334-347.

Miller. R., & Bradbury, J. (1998). Academic performance of first and second language students: Disadvantage and under-preparedness. *South African Journal of Science*, *94(3),* 103-113.

Onwuegbuzie, A.J., DaRos, D., & Ryan, J. (1997). The components of statistical anxiety: A phenomenological study. *Focus on Learning Problems in Mathematics*, *19(4),* 11-35.

Secada, W.G. (1996). Urban students acquiring English and learning Mathematics in the context of reform. *Urban Education*, *30(4),* 422-447.

Shultz, K.S., & Koshino, H. (1998). Evidence of reliability and validity for Wise's attitude towards statistics scale. *Psychological Reports*, *82*, 27-31.

Verhoef, M.M. (2001). Skok oor Vaalpukke-eerstejaars se swak taal. Vaalweekblad, 3, Aug.1-3.

Wise, S.L. (1985). The development and validation of a scale measuring attitudes towards statistics. *Educational and Psychological Measurement, 45,* 401-405.