UNDERSTANDING OF CHANCE AND PROBABILITY CONCEPTS AMONG FIRST YEAR UNIVERSITY STUDENTS

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In higher education, the quality of learning outcomes and the way in which students approach their studies have been shown to be related to the students' conceptions of a subject and how it is learned. In a number of South African universities, an area of concern is the failure rate at the end of the first year. Since there is a close link between learning outcomes and failure rate, it is important to find out how students conceptualise and learn the subjects they are studying. In statistics, many students lack understanding of basic concepts and their difficulties may be related to their conceptualisation of the subject and their learning experiences. This study is an attempt to gain insight into first year students' conceptions of chance and probability concepts and their approaches to learning statistics.

INTRODUCTION

The quality of learning outcomes in higher education and the way in which students approach their studies have both been shown to be related to how the students conceptualise a subject and its learning (Marton, 1988; Prosser and Millar, 1989; van Rossum and Schenk, 1984; Trigwell and Prosser, 1991). In South Africa, as elsewhere, "one of the most frequent criticisms levelled at ... universities is the failure rate at the end of the first year" (Romainville, 1994, p. 359). Since there is a close link between learning outcomes and failure rate, it is important to find out how students conceptualise and learn each of the subjects they are studying, in addition to the conventional assessment of their performances. Ultimately this will serve to inform and guide lecturers of first year students as to which strategies might be more advantageously used in the teaching of those subjects.

In statistics, it is common knowledge that many students lack understanding of basic concepts, a view which is confirmed by numerous research studies (Garfield and Ahlgren, 1988). Research in Australia (Crawford, Gordon, Nicholas and Prosser, 1994; Gordon, 1995; 1997; Gordon, Nicholas and Crawford, 1996) suggests that in terms of the quality of students' learning of mathematics or statistics, there is a structural relationship between students' conceptions of the subject and their approaches to learning it. Support for this idea has been found in South Africa (Glencross, Kentane, Njisane, Nxiweni and Mji, 1997; Mji, 1995). This paper reports on a further research study aimed at gaining

insight into first year students' understanding of chance and probability concepts and their approaches to learning statistics.

METHOD

Phase 1 of the project, the pilot study, was carried out towards the end of the 1997 academic year. First year students at the University of Transkei were asked to complete a four-part questionnaire designed (1) to assess their understanding of basic concepts of chance and probability, (2) to find out what they think Statistics is and how they study and learn it and (3) what feelings they have toward the subject. The questionnaire was administered near the end of the fourth term, about four weeks before the end-of-year examinations. Section A of the questionnaire contained questions related to demographic data, such as gender, age, home language, subjects currently being studied and the subject liked best. Section B consisted of 15 questions about chance and probability concepts, most being in multiple-choice format linked to an open-ended question: 'Why did you choose this answer?' In Section C, students were given open-ended questions which asked 'What do you think Statistics is?' and 'How do you usually study and learn Statistics?', while the final part of the questionnaire consisted of a 24-item attitude questionnaire in Likert scale format.

STUDENTS

The questionnaire was completed by 62 Statistics I students, of whom just over half (33, i.e. 53.2%) were male. Ages ranged from 17 years to 30 years (mean = 20.8 years). A majority (56, i.e. 90.3%) gave Xhosa as their home language, the remainder offering Afrikaans, English, Sesotho and Zulu among them. More than three quarters (79%) of the group were studying two or three science subjects in addition to Statistics, with a few taking Psychology, Geography, Education or Economics. In terms of the *best* subject, Statistics had overall rank 6, behind Chemistry (1), Botany and Computer Science (2), Zoology (4) and Mathematics (5).

RESULTS

Chance And Probability Concepts

Scores ranged from 2 to 13 (maximum 15), with a mean of 8.2. There was a significant difference ($p<0.01$) between the means scores of males (9.5) and females (6.8). As far as *best* subject was concerned, there were no significant differences between mean

scores of students. The students' overall performance on each of the 15 questions varied from 79.0% on Question 8 [Bag E has 2 black and 2 white counters; Bag F has 4 black and 4 white counters; which bag gives a better chance of picking a black counter?] to 3.2% on Question 11 [If 12 coins are tossed many times, which result will happen most often? 2 heads and 10 tails; 5 heads and 7 tails, etc]. On the basis of a group mastery level of two thirds (67%) of correct answers, only seven of the questions were answered satisfactorily by the students. The results suggest that the concepts of *equally likely events* and probability as *relative frequency* are not sufficiently well understood by many students and that the (incorrect) concept of probability as *frequency only* may be somewhat stronger.

Studying And Learning Statistics

Due to unforeseen circumstances, the analysis of the responses to the open-ended questions which asked 'What do you think Statistics is?' and 'How do you usually study and learn Statistics?' has not been completed at the time of writing. However, the initial indications are that students' conceptions of Statistics are mostly fragmented, e.g., 'Statistics teaches you to calculate probabilities', rather than cohesive, e.g., 'Statistics is about solving problems about populations'. Students' methods of studying and learning Statistics appear to be dominated by surface level approaches, e.g., 'I practise by doing lots of examples and questions from past papers', with few students describing deep approaches, e.g., 'I try to understand the theory and link it to the examples and problems'.

Attitudes Toward Statistics

The minimum and maximum possible scores on the attitude scale were 24 and 120, respectively. The students' attitudes scores ranged from 52 to 107, with a mean of 86.3. Only one student had a score showing a negative attitude toward Statistics, 35 (56.5%) showed positive attitudes, with the remainder showing neutral attitudes. The correlation between the 'chance and probability concepts' score and attitude score was close to zero.

DISCUSSION

The results on the 'chance and probability concepts' test have indicated that the concepts of events being *equally likely* and of probability as *relative frequency* were not well understood by the group as a whole. Students' conceptions of Statistics suggest that they have a fragmented view of the subject, while their approaches to learning rely mostly on learning by practising lots of examples. Students attitudes were predominantly positive, although there was no correlation between attitudes and performance. The results from this pilot study are sufficiently encouraging to justify a further exploration and Phase 2 of the project will be carried out during 1998. This will involve administering the questionnaire as a pre- and post-test to the 1998 first year statistics students. In addition, semi-structured interviews will be used to probe more deeply into students' understanding of the concepts addressed in the test.

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