Students' and Lecturers' Perceptions of Factors Influencing Students' Success in First-Year Undergraduate Mathematics Courses.

Glenda Anthony - Massey University

Qualitative data from lecturers and students were used to identify factors which were perceived as making the most important contributions to students' academic success or failure in first-year mathematics courses. A questionnaire based on this information highlighted similarities and differences in the perceptions of lecturers and students about influences on students' success and failure. The results confirm the importance of motivation and suggest further research is needed in the areas of active learning and student effort and workload.

Introduction

Most universities offer a range of first-year mathematics courses which cater for students of varying background knowledge and career aspirations. While in the past the assumption was that students entering a standard first-year mathematics course had recently completed a complementary mathematics course at secondary school, it is increasingly evident that students in calculus and algebra courses come from a wider spectrum. On enrolment students are advised of the recommended prerequisite mathematical background - but what emphasis should we place on this, and what should our response be to the mature student who successfully studied mathematics many years ago, or the otherwise successful student who, despite a weak background in mathematics, needs mathematics as a prerequisite for another major?

Models of learning (Anthony, 1996b; Biggs, 1993) all suggest that presage, process and context factors interact to influence outcomes of learning. While student presage factors such as prior content and metacognitive knowledge, and previous learning experiences are acknowledged as significant factors many of the other factors influencing students' success occur after enrolment. Teaching strategies, student motivation, approach to studying, cultural expectations, and numerous other factors are likely to influence students' success in undergraduate mathematics courses.

Research Study

The purpose of this study was to identify specific factors which are seen as having important influences on students' level of success. In support of the view that perceptions are not stable entities within cognitive structures but are dynamic and context dependent (Prosser, Trigwell, & Taylor, 1994) the study is specific to first-year mathematics courses. Moreover, because teaching and learning processes jointly influence learning outcomes the study is based on the perceptions of both lecturers and students. Crawford, Gordon, Nicholas and Prosser's (1994) study involving beginning mathematics students stressed "the need for a shift in attention away from teaching and learning as independent activities towards a more systemic examination of the relationships between the two activities and the context in which they occur" (p. 344). An exploration of potential differences in lecturers' and students' perceptions will provide an opportunity for both teachers and students to assess their respective roles in the learning process.

The study was conducted in three phases involving exploratory open-ended questionaries, Likert-type questionnaires and student interviews. The first two phases, which are reported in this paper, use a similar methodology from an earlier study (Killen, 1994) which involved students and lecturers across all university disciplines.

Phase One

In an attempt to identify factors which have important influences on success 65 students (from a range of first-year mathematics courses) and 22 lecturers and tutors (all experienced in first-year undergraduate teaching) were asked to complete a questionnaire on which they responded freely to two items: "List five factors that you think are most

important in contributing to students' success in first-year mathematics courses" and "List five factors that you think are most likely to lead to student failure in first-year mathematics courses". A covering information letter explained the purpose of the research and indicated that success was defined as completing the course and receiving a passing grade, whereas failure was defined as receiving a fail grade.

The students and lecturers identified 63 and 53 separate factors, respectively, (such as "completing assignments" and "interesting lectures") as contributing to student success, and 60 and 54 factors, respectively, (such as "not attending lectures" and "boring lectures") as contributing to student failure. These responses were analysed separately and placed into the broad categories suggested by Killen's (1994) study: lectures, course, students and other external factors. While both lecturers and student attributed student success and failure to the same four general influences there was a difference emphasis on the factors within each category. For students, 24% of success factors related to lectures, 23% to course material and design, 47% to the student, and 6% to other external factors. By comparison, lecturers' responses included 15% related to lectures, 12% related to the course, 68% related to students and 5% related to other external factors. For factors influencing failure, student responses were apportioned 21% to lectures, 15% to course material and design, 55% to students and 5% to external factors. By comparison, lecturers' responses included 13% of factors related to lectures, 10% related to the course, 67% related to students and 10% related to other external factors. Thus, the trend indicated in this initial data suggested that while both students and lecturers suggested student factors most often, students tended to place more responsibility for their level of success on the lectures and course design that did lecturers.

Phase Two

In order to investigate the trends that were evident in the data from the first phase of the research, the factors that had been identified by students and lecturers as contributing to student success and failure were used to create two parallel questionnaires (one for students and one for lecturers). The questionnaires contained 40 statements related to factors influencing student success and 37 statements related to factors influencing student failure in first-year mathematics. The items were selected on the basis of frequency from the initial surveys in phase one of the research. The questionnaires were administered to 92 students (64 male and 28 female) nearing the end of a first-year calculus course and 26 lecturers (19 male and 7 female). The respondents used a five-point Likert-type scale to indicate the extent to which they thought that each factor influenced student success or failure (1= not at all, 5= greatly).

RESULTS

'Success' Questions

On all but two items on the 'success' scale student responses covered the full range from 1 (not at all) to 5 (greatly). The items concerning the availability of help and plenty of worked examples in the lectures received a minimum score of 2. For lecturers the range of responses reflected a more unified opinion, with 13 of the top-ranked responses having a minimum score of 3 or 4. In general, ranking agreement between students and lecturers was high (Spearman's Rho was 0.611, p < .01). The item rated most highly (most likely to influence success) by both students and lecturers was "self-motivation". Additionally, students' high ranking items indicated that assessment demands were very important, as was the quality and availability of support, but high ranking items did not include "regular practice of examples".

Data analysis, using the non-parametric Mann-Whitney U test based on ranking, was used to determine if there were any significant differences between lecturers' and students' scores for each item. An analyses of scores and respective ranking of 'success' items is presented in Appendix A. Responses for five items were significantly different at the 1% level, two at the 5% level, and a further two at the 10% level.

Lecturers gave significantly more support for the need for courses to have realistic expectations of prior knowledge and clear requirements, regular practice of examples, and adequate background knowledge: all factors which should support optimal motivation and sustained student involvement (Paris & Turner, 1994).

In contrast, students placed more emphasis on factors related to course design and organisation (availability of help and availability of information booklet in exams) and student behaviours (regular attendance at lectures and tutorials, taking notes during lectures, active attention in lectures and an appropriate balance of social and academic life).

'Failure' Questions

It is apparent, that for the most part, those factors which influence failure most significantly indicated a lack of those that influence success. On all items on the 'failure' scale student responses covered the full range from 1 (not at all) to 5 (greatly). Again, lecturers appeared to be in much more agreement for 'failure' items, with minimum scores of 2 for most items and scores of 4 or 5 for "insufficient work". The rank order correlation (Spearman's Rho) was 0.586 which is significant (p< .01), but not as strong as the rank order correlation on the 'success' questionnaire. The items "lack of effort" and "lack of motivation" were jointly ranked highly influential factors for failure by both lecturers and students.

There was considerable overall agreement in scores (Appendix B) with only four items which showed significant differences at the 5% level and a further six items at the 10% level. Lecturers placed more importance on poor study techniques, insufficient work, inadequate mathematics background knowledge, difficulties adapting to university life, and problems with student's personal life, than did students. These factors are all related to student characteristics or behaviours. In contrast, items which were rated significantly higher by students included boring presentations of lectures, non attendance of lectures, and a perceived lack of relevance of paper content. These factors all related to lectures and course design.

Related to lack of effort is the item "insufficient work". This item was ranked first by lecturers but only eighteenth by students. In an additional section in the questionnaire concerning student workload only half of the students reported attending all four mathematics lectures per week and 55% of the students reported spending 4 or fewer hours on individual mathematics study and assignment work per week. The disparity between lecturers' expectation and student work is clear when less than 20% of students reported completing the recommended hours of study and lecture attendance. These figures also reflect students' higher rankings of attendance of lectures and tutorials than regular practice of examples and reverse order rankings for lecturers.

Both students and lecturers rated poor study techniques as a more influential factor in failure than inadequate mathematics background knowledge. For many students poor performance is largely due to ignorance about the study skills required, or the inability to apply these skills appropriately, rather than lack of ability (Manalo, Wong-Toi, & Henning, 1996).

Comparisons by Performance

Comparison of lecturers and students by performance further differentiates differences in perceptions. In response to the 'success' questionnaire A-grade students accorded less importance (p < .05) than lecturers to adequate background knowledge, regular practice of examples and reading before lectures, but more importance to regular attendance of lectures, active attention in lectures, taking notes in lectures, assignment completion, and the availability of the information booklet in exams and help in general. Failing students, on the other hand, placed less importance than lecturers on the need for the course to have clear requirements and realistic expectations of prior knowledge, and adequate background knowledge, and more importance than lecturers on the availability of information booklet in exams and note-taking in lectures.

In response to the 'failure' questionnaire A-grade students accorded less importance (p < .05) than lecturers to the influence of lecturers with unrealistically high expectations of students, inadequate background knowledge, too much content, insufficient work, difficulties in adapting to the university environment, and financial and persons problems. However, A-grade students ranked lack of relevance and non-attendance at lectures as more important contributors to failure than did lecturers. Failing students showed only three significantly different responses to lecturers on the 'failure' questionnaire. They accorded less importance to insufficient work and rote learning and more importance to too many demands on time.

Comparison of student responses, based on student success (defined as receiving a passing grade) and failure, were also conducted. Statistically significant findings (p < .05) indicated that when considering factors influencing success successful students placed more importance on:

- the availability of worked examples in lectures and tutorials;
- clear presentation of lectures;
- the need to make the paper requirements clear;
- assignment completion;
- understanding rather than rote learning;
- the ability to work independently;

and less emphasis on reading before lectures.

When considering factors influencing failure, successful students suggested that rote learning was a more significant influence than did unsuccessful students. Unsuccessful students, however, considered that difficult lectures, inadequate mathematics background and too many demands on time were more influential factors than did successful students.

Gender Comparisons

No statistically significant (p < .05) differences between student gender were noted in the responses to the 'success' questionnaire and only two differences were found in the responses to the 'failure' questionnaire. Females placed less importance on the influence of boring lecture presentations, and males placed less importance on assignment completion as a reason for failure. These finding may offer limited support to gender differences for attributions to failure, with males less likely to attribute effort and females less likely to attribute external sources. Furthermore, assuming students' perceptions influence learning approaches (Taylor, 1996), then the overall lack of differentiation by gender offers support to Richardson's (1993) assertion that there is no significant difference between male and female responses to approaches to studying.

Discussion and Implications for Further Research

Motivation is seen by both students and lecturers as the most influential factor related to levels of success. While highlighting the importance of motivation, data of this type does not allow us to explore whether or not motivation is directed towards achievement or performance goals, nor investigate factors in the learning environment which serve to increase or decrease motivation. The fact that students, and A-grade students in particular, placed significantly more importance on the regular attendance of lectures than did lecturers may reveal the indirect motivational values, apart from cognitive content, that lectures offer. Lecturers in this study, aware of the fact that study material prepared for distance teaching is available for students to study independently, may regard lectures as an 'extra'. However, by helping students become aware of conflicting points of view or by challenging ideas that students have previously taken for granted lectures can stimulate further learning. Moreover, the lecturer's own attitudes and enthusiasm, modeling of problem solving and mathematical thinking are added values which are difficult to portray in written study material.

Within the lecture situation students placed more importance than lecturers on active learning and note-taking. Does this mean that lecturers see their role as information providers, rather than providing opportunities for students to be actively engaged in analysing and processing information? Burroughs-Lange (1996) found that lecturers assumed student needs were about mastery of the subject matter rather than the needs that had been articulated by their students. Further research is needed to explore approaches involved in the lectures from both the lecturers' and students' perspective.

How do students and lecturers apportion responsibility for learning? Studies (Anthony, 1996a; Burroughs-Lange, 1996) suggest that in the classroom/lecture situation teachers do most of the cognitive work, leaving students to do the less demanding tasks. Broadly speaking, it appears that lecturers in this study were more inclined than students to attribute student failure either to factors which were related to student entry characteristics or within the control of students. Students, however, placed greater

emphasis than lecturers on those factors related to lectures and course design. Taylor (1996) noted that although students expressed a clear, but individual sense of who was responsible for what in terms of learning, few appreciated that the negotiation and exercise of that responsibility could be a joint rather than individual project.

When comparing successful and unsuccessful student, A-grade students accorded more weight than lecturers to those factors directly within their control, such as lecture attendance, active participation and assignment completion, whereas failing students placed more importance than lecturers on the supply of information, either in the form of lecture notes, or information booklet. A distinguishing factor between successful students and failing students was the relative importance placed on the need to make the paper requirements clear. Other studies (Anthony, 1996b; Jones & Nuich, 1992) found significant variation in how well students are 'cued into' the kind of work that is necessary to achieve examination success. 'Cue deaf' students can put in a lot of hard work, achieve significant understanding, yet because of ineffective study skills achieve little success in terms of grades.

This study provides a starting point for bringing together the voices of students and lecturers. In particular, the comparison between students' and lecturers' perceptions provides a basis for further research into how perceptions are formed, and what influences perceptions have in affecting learning and teaching approaches and subsequent learning outcomes. The results of the initial phases of this study suggest that the exploration of the teaching-learning phenomenon from the viewpoint of all participants will build an environment of open communication and understanding between teacher and student, with the expectation that improvements in the quality of learning and education will follow.

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Appendix A: Comparison of lecturers' and students' responses on 'success' items

Questionnaire Item	Mean Student	Mean Lecturer	p level	Rank Student	Rank Lecturer
Self motivation	4.46	4.73		1	1
Study for tests and exams	4.34	4.58		2	2
Making sure you understand the basics in each topic	4.33	4.35		3	5
Assignment completion	4.20	4.19		4	13
Willingness to seek help when needed	4.18	4.38		5	3
Availability of help	4.17	3.77	.006	6	25
Clearly presented lectures (boardwork and language)	4.15	4.23		7	9
Plenty of worked examples in the lectures and tutorials	4.15	4.15		8	18
Desire to understand the material rather than rote learn	4.13	4.27		9	8
Assignments are related to lecture content	4.12	4.00		10	16
Supportive and approachable lecturers/tutors	4.11	4.19		11	11
Consistent effort	4.07	3.96		12	17
Paper material is well designed with lots of examples	4.07	4.31		13	15
Well structured lecture presentations	4.05	4.15		14	14
Regular attendance at lectures and tutorials (where appropriate)	3.99	3.50	.025	15	31
Taking notes during lectures	3.96	2.85	.000	16	39
Revising past test and exam questions	3.95	3.73		17	27
Ability to work independently	3.91	3.81		18	24
Suitable study environment free of distractions	3.90	3.62		19	29
Regular practice of examples	3.89	4.31	.097	20	6
Effective study skills	3.87	4.19		21	12
Student interest in the paper	3.86	3.92		22	19
Active attention in lectures	3.84	3.38	.049	23	34
Ability to cope with stress	3.83	3.58		24	30
The paper requirements are made clear	3.82	3.88		25	20
Overall workload for paper is appropriate	3.81	3.81		26	25
Lecturer/tutor is enthusiastic	3.80	3.85		27	22
Availability of 'information booklet' in tests and exams	3.79	2.76	.000	28	40
Interesting lectures	3.77	3.85		29	23
Paper has realistic expectations of prior knowledge	3.75	4.38	.003	30	4
An appropriate balance of social and academic life	3.72	3.35	.090	31	35
Ability to think mathematically	3.71	3.68		32	28
Lecturer who can inspire students	3.71	3.88		33	21
Time management	3.69	3.92		34	18
Appropriate level of internal assessment	3.68	3.42		35	33
Adequate background knowledge	3.58	4.23	.005	36	10
Orderly and controlled lecture environment	3.47	3.42		37	32
Relevance of paper to other subjects	2.87	2.88		38	38
Support from friends	2.62	2.92		39	37
Reading material before each lecture	2.61	3.00		40	36

Appendix B: Comparison of lecturers' and students' responses on 'failure' items

Questionnaire Item	Mean Student	Mean Lecturer	p level	Rank Student	Rank Lecturer
Lack of effort	4.13	4.55	.098	1	2
Lack of self-motivation	4.11	4.36		2	3
Lectures are difficult to understand	4.09	4.16		3	6
Poor quality lecturing	4.00	4.12		4	8
Not keeping up with paper progress	3.97	4.32		5	4
Failure to seek help when needed	3.94	4.16		6	7
Lack of interest in the paper	3.87	3.64		7	22
Boring presentations by lecturers	3.86	3.48	.046	8	30
Lecturer/tutor is unsupportive or unapproachable	3.85	3.72		9	19
Not completing assignments	3.83	4.08		10	9
Overall workload too heavy	3.81	3.79		11	17
Becoming discouraged	3.78	3.92		12	13
Not paying enough attention in lectures	3.77	3.52		13	27
Not enough worked examples in paper material	3.76	3.92		14	14
Poor study techniques	3.74	4.20	.012	15	5
Not attending lectures or tutorials (where appropriate)	3.74	3.24	.065	16	34
Under-estimation of the work required	3.69	3.92		17	12
Insufficient work	3.68	4.60	.001	18	1
Too many demands on students' time	3.68	3.52		19	28
Inability to balance study and social commitments	3.68	3.50		20	29
Heavy paper workload	3.65	3.40		21	33
Emphasis on rote learning rather than understanding	3.61	3.72		22	18
Lack of a regular study routine	3.60	3.64		23	23
Inadequate mathematics background knowledge	3.56	3.96	.065	24	11
Too much content in lectures	3.55	3.80		25	16
Lack of mathematical ability	3.54	3.54		26	26
Suitable help difficult to find	3.51	3.84		27	13
Noisy or crowded lectures	3.49	3.60		28	24
Lack of confidence	3.43	3.68		29	21
A perceived lack of relevance of the paper content	3.37	3.00	.066	30	36
Expectations for the paper are not clear	3.36	3.40		31	32
Complacency or over-confidence	3.34	3.56		32	25
Lecturers/tutors who have unrealistically high expectations of students	3.30	4.04	.003	33	10
Problems with personal life	3.15	3.71	.051	34	20
Difficulties adapting to the university environment	3.03	3.48	.083	35	31
Not enough internal assessment	2.85	2.76		36	37
Financial problems	2.67	3.00		37	35