Student Expectations of Studying Mathematics at University

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When students move from school to university they have to overcome many problems, academic, social and personal. One of the important factors influencing this transition is the students' own expectations. In this study we have undertaken an investigation of mathematics students in the UK and in Portugal. We concentrated on exploring how students felt their university experience would compare with school, in a number of areas, covering aspects of their own work and study regimes, the anticipated conditions of learning and their interactions with mathematics. The work was part of a wider investigation of the transition from school to university mathematics carried out at the University of Southampton in the UK, and Universidade do Minho (Braga) in Portugal, made possible by a grant from the British Council Treaty of Windsor programme. We conclude that in a number of important areas the students' expectations are not realised, in significant ways. It is also clear that in some areas there are differences between the UK and Portugal, and this suggests that the issues should be explored in relation to other countries as well.

It is somewhat surprising that major reports into higher education in both the UK and in Portugal have not addressed students' prior expectations. In the UK the Dearing report (1997) addressed student demand, but it was mainly in terms of population parameters and economic needs. Likewise the report on the assessment of university degrees for public universities in Portugal (Comissão, 1998) made no comment about this issue.

Some recent research (Daskalogianni & Simpson, 1999, 2001, 2002) investigated this on a case study basis, exploring individual students' ways of interacting with mathematics. Their findings emphasise that attitudes and beliefs are one of the key elements in the transition from school to university mathematics.

Prior expectations influence student behaviour. We did not undertake a systematic investigation of this relationship, but it is clear to lecturers at an anecdotal level. For example the relatively low level of active participation in lectures seems to be related to prior expectations about this. It is therefore important for lecturers to be informed about the students' expectations, and it is clear from the low level of "no opinion" responses to our questionnaire that most students arrive at university with these expectations well formed.

Methodology

This piece of work complements the case study approach by means of questionnaires given to one year's intake of mathematics students. In the case of the University of Southampton we surveyed the first year intake, numbering 118 students, into the Faculty of Mathematical Studies in September 2001, early in the very first week of the course. We were interested in whether the students' responses would change significantly during their early weeks, and so we repeated the survey just after the Christmas vacation, when 93 of the students participated.

In the case of the University of Minho in Braga we surveyed those students undertaking the introductory first year calculus course. In Portugal the years of study for

students are not as clearly differentiated as in the UK. It is common for many students to repeat individual courses, sometimes several times, and so those studying this calculus course in 2001 were heterogeneous with respect to their year of study. We therefore introduced an additional variable distinguishing whether students were "first registration" or not, giving an opportunity to see whether the attitudes of new students were significantly different from those who had been at the university for some time. The survey was done at the beginning of the course, before the students had time to interact and exchange attitudes. It was clear to us that a follow-up questionnaire of the type used in Southampton would not be so informative because of the transmission of attitudes from repeating students to first registration students which takes place during the course. There are complementary studies which explore the students' experience as they report on it during the course (for example Rego & Sousa, 1998).

The questionnaire was designed to explore expectations and opinions. An example was given on the questionnaire form, and because the survey was carried out during class time we were also able to explain what was required. The example given on the UK questionnaire was as follows

Compared with A-level, I expect that I will have to work: **M**ore, **L**ess, **S**ame, **N**o opinion.

After the questions we listed some topic areas and asked students to place them in relative order of difficulty as they thought they would find them.

Questionnaire Results

We have commented on some of the most significant issues explored rather than giving details of the response to each question, for brevity. More detailed analysis is available from the authors. We have grouped allied questions and given the percentages, followed by comments. So'ton A refers to the initial questionnaire with Southampton students, and So'ton B refers to the follow-up questionnaire. Where the percentages do not sum to 100 the residue represents the relatively few "No Opinion" responses.

It was a little sad that a small percentage of Southampton students felt initially they would not enjoy mathematics as much as at school. What is disturbing is that after one term this percentage had risen substantially. In Braga a significantly greater proportion expected to enjoy mathematics. However a large proportion fail on their first attempt, so their expectations are not realised.

It is a matter of concern that many of new Southampton students expected that there would be less student participation in lectures than at school. These expectations were clearly confirmed in practice, as the follow-up data shows. There is a significant difference in expectation in Braga, with half the students expecting class participation to be part of their learning experience to a greater degree than at school. These expectations are not realised, and in many cases they are told explicitly that they are not to interrupt in lectures.

Table 1
Questions Concerning Student Participation and Study Regimes

Enjoyment of mathematics compared with school			
So'ton A	More 33.9	Less 4.2	Same 59.3
So'ton B	More 23.7	Less 17.2	Same 58.1
Braga	More 77.2	Less 4.5	Same 18.1
Level of participation in lectures compared with school classes			
So'ton A	More 3.4	Less 21.2	Same 17.8
So'ton B	More 6.5	Less 67.7	Same 22.6
Braga	More 50.0	Less 18.2	Same 28.8
Working harder compared with school			
So'ton A	More 86.4	Less 3.4	Same 10.2
So'ton B	More 74.2	Less 1.1	Same 22.6
Braga	More 78.8	Less 3.0	Same 15.1
Study time expected outside class compared with school			
So'ton A	More 80.5	Less 5.9	Same 11.9
So'ton B	More 68.8	Less 3.2	Same 28.0
Braga	More 63.6	Less 3.0	Same 33.3

Students from both Southampton and Braga initially thought they would have to work harder at university. After one term the percentage had fallen, but not significantly. Nearly all first registration students in Braga came with this expectation, and 75% of those from subsequent years still felt they had to do more work than at school.

Most Southampton students anticipated that they would have to spend more time studying outside class than they did at school. After one term this had decreased. In Braga fewer, but still a majority, expressed this view.

The expectation of half the new Southampton students that they would be able to understand material in lectures less than at school is somewhat disconcerting! Because of the timing of the initial questionnaire it was clearly not based on actual experience of university lectures. In fact after a term slightly fewer reported understanding less. However the majority of the Portuguese students expected to understand university mathematics in lectures better than in school. Students entering mathematics degrees in Portugal are seen as having a high self-esteem. They perceive university teachers as the best – at the top of the hierarchy – and so they expect to have a high level of understanding. Sadly these expectations are dashed and very many (around 80% in Analysis) fail in their first year.

A majority of Southampton respondents expected that they would find first year university mathematics more difficult than school mathematics, while over a quarter expected the level of difficulty to be about the same. These didn't change much after a term's study. Significantly fewer of the Portuguese students felt that the mathematics would be harder, while nearly a quarter thought they would actually find it easier. This is part of the overall picture of high expectations which the previous question picked up.

Table 2
Questions Relating to Learning and Understanding

Understanding material in lectures compared with school classes			
So'ton A	More 11.0	Less 50.0	Same 21.1
So'ton B	More 12.9	Less 22.6	Same 36.6
Braga	More 78.8	Less 9.1	Same 18.2
Difficulty of first year university mathematics compared with school			
So'ton A	More 61.0	Less 7.6	Same 27.1
So'ton B	More 67.7	Less 1.1	Same 25.8
Braga	More 40.9	Less 24.2	Same 27.3
Learning things for oneself compared with school			
So'ton A	More 94.1	Less 1.7	Same 1.7
So'ton B	More 74.2	Less 6.5	Same 15.1
Braga	More 47.0	Less 24.2	Same 25.8
Amount of help available outside class compared with school			
So'ton A	More 42.4	Less 21.2	Same 31.4
So'ton B	More 23.7	Less 37.6	Same 35.5
Braga	More 77.3	Less 10.6	Same 9.1

Most of the students arrived in Southampton with the expectation that they would have to find out more for themselves than at school. After a term this had dropped to just under three quarters. In Braga fewer than half shared this view, with about a quarter thinking it would be much the same as at school. This reflects a significant difference in the expectation of continuity of experience between school and university between Portugal and the UK.

Expectations about the amount of help available outside class were mixed, as the data shows. However after one term fewer than a quarter of the Southampton students reported more help being available. (One must be aware that they may not always have sought such help.) In Braga there was a significantly higher expectation of a lot of help being available. One possible factor here is the considerable amount of private tutoring which takes place in Portugal in the years leading up to university entrance, but it also reflects an expectation of the university situation itself.

Just over half the Southampton students thought they would have to use graphical calculators more than at school, and a quarter less. This may well be a reflection of the variation in use across schools. After one term the change was startling. Now over half reported that they were using them less than at school. One can speculate on whether this is a true reflection of a difference between university and school mathematics, relating perhaps to an increased emphasis on general reasoning and proof, and a reduction in the "experimental" aspect of mathematics. A further consideration may be an increase in the use of computers at university, and the next question relates to this. The response from Braga is somewhat complicated by the fact that the use of graphical calculators in schools has increased only recently in school mathematics as a result of recent curriculum reform. This partially explains why fewer Portuguese students felt they would be using them more.

Table 3
Issues relating to use of technology

Use of graphical calculators compared with school			
So'ton A	More 52.5	Less 11.9	Same 24.6
So'ton B	More 5.4	Less 51.6	Same 31.2
Braga	More 34.8	Less 21.2	Same 36.4
Learning about computers compared with school			
So'ton A	More 85.6	Less 2.5	Same 11.0
So'ton B	More 79.6	Less 5.4	Same 11.8
Braga	More 78.8	Less 6.1	Same 15.1

Gender

We note that in Portugal mathematics students have traditionally been mainly women. This is changing slowly, but of the students in Braga who completed the questionnaire nearly 80% were female. (In Portugal the main career followed by mathematics graduates is school teaching, and this has traditionally been dominated by women.) This contrasts with the situation in the UK where traditionally there have been about twice as many men as women studying mathematics degrees, and where career outlets are much more varied. In the case of the Southampton students participating about 40% were female. In neither institution was there evidence from the responses of systematic gender differences.

Another study carried out in Braga (Santos, 2001) suggested possible gender differences in attitudes to work. For example it is reported that in the Universidade do Minho male students are involved in extra-curricular activities to a greater extent than female students.

Topic difficulty

As explained above, we listed some topic areas (Algebraic Manipulation, Differentiation, Integration, Coordinate Geometry, Proof) and asked students to place them in relative order of difficulty as they though they would find them. The question quantified this by asking for relative position on a line. Again an example was given, as follows

Please rank the topic areas in the order of difficulty you think you will find them. Mark them on the line with the easiest to the left. Leave gaps to represent differences in difficulty. In the following example you think B will be easiest, and quite a lot easier than C or A. You think A will be just a bit harder than C.

Easiest		*Hardest*
B	C	A

Students in Portugal do not meet integration in school. They all study some Statistics however, and so we substituted Statistics for Integration in their topic list.

In order to give a numerical measure for the relative difficulty as the students indicated topics on the line, we measured the positions of their indications from right to left (so that harder topics had lower numbers), normalising to a scale of 1 – 10.

Table 4
Statistics for Southampton

Topic	Original Mean (SD)	Follow-up Mean (SD)
Algebraic Manipulation	71.0 (19.8)	71.3 (22.9)
Differentiation	67.7 (19.8)	71.9 (19.2)
Integration	54.2 (22.0)	46.6 (24.0)
Coordinate Geometry	52.6 (22.0)	52.5 (22.8)
Proof	33.5 (21.0)	17.5 (17.1)

Some elementary statistical analysis confirmed what this data suggests, namely that the students initially grouped Algebraic Manipulation and Differentiation together as the easiest pair, and that this was confirmed at the follow-up stage. Next they felt initially that Integration and Coordinate Geometry would be of roughly the same middling difficulty, and they felt that Proof would be found most difficult. The gaps between these three groupings were sufficiently wide to be statistically significant. The follow-up suggests that they found Integration significantly more difficult than anticipated, and that Proof was even more difficult that they originally thought, despite the fact that one of the first semester courses aims to address issues of proof explicitly and to help students learn to construct proofs.

Table 5
Statistics from Braga

	Overall	First Registration	Repeat Students
Topic	Mean (SD)	Mean (SD)	Mean (SD)
Algebraic Manipulation	43.6 (22.3)	38.0 (20.1)	52.2 (23.2)
Differentiation	82.3 (18.7)	83.6 (19.3)	80.3 (18.1)
Statistics	70.4 (25.6)	71.5 (25.3)	68.7 (26.5)
Co-ordinate Geometry	50.5 (26.6)	42.6 (24.6)	62.6 (25.3)
Proof	27.5 (27.0)	35.4 (27.9)	15.2 (20.7)

It is quite clear that students in both countries report that Proof is the topic they have most difficulties with. This is an internationally recognised problem (see for example G Hanna 2001). Unfortunately the many studies carried out on Proof do not seem to offer much practical help to lecturers.

Beyond First Registration

As we remarked above, we felt that for the students from Braga we should investigate whether there were significant differences in the responses between first registration students and repeating students. For most of the questions this did not occur, but there were some where such differences were evident, and statistically significant.

There was a statistically significant reduction in the proportion of students who felt they would enjoy university mathematics more than at school from first registration to repeating. It seems clear that this is a reflection of the first year experience of the repeating students who have already experienced a lack of success, and whose level of enjoyment may have been influenced by their lecturers, who traditionally have little interaction with their classes.

A significantly greater proportion of repeating students felt they would understand material in lectures than did first registration students. This is despite the fact that they have already failed at least once. Lecturers commonly report that repeating students feel they have "heard it all before" and do not need to pay attention or even attend classes. The pass rate for repeating students does not confirm their apparent optimism. (Around 80% of repeating students failed the Analysis examination in the summer of 2002.)

We have already commented on some of the factors involved in the students' first year experience which relate to the low level of participation in lectures: it is perhaps therefore not surprising that repeating students, who have already been through this experience, give a significantly lower rating here.

Conclusions

We believe that this study indicates the importance of students' expectation as a factor in the way they cope with the first stages of their university course (which of course influences subsequent progress). It is therefore important that lecturers are aware of these factors so that they can take them into account in designing the learning experience that students will undergo. Even though we surveyed only one cohort of students from only two universities, the diversity of views encountered, and the significant differences between our countries, show that we cannot rely on any preconceived notions of students' attitudes and behaviour, but that research should inform the context in which we are teaching.

The social context for learning is important, although we explored this only to a limited extent. Lecturers should know about the extent of student involvement in social activity, and about the students' view of the relationship between themselves and their lecturers. We did not investigate the extent to which our students undertake part-time employment, which is bound to have an effect on their studies. However a national report in the UK (UNITE/MORI, 2002) suggests that 43% of UK undergraduates have some kind of part-time job during term time. In Portugal this is not thought to occur to anything like the same extent, although the issue has not been investigated systematically.

One important area concerns students' expectations about their own study habits. The questionnaire responses indicate that they expect to work hard and to study outside class, but that they anticipate finding this difficult. This suggests that some guidance on study skills at appropriate stages during the course may enable students to utilise their propensity for hard work more effectively. One aspect concerns coursework, where they expect the tradition of regular homework encountered at school, with feedback from the teacher, to be continued at university. This appears not to happen in Portuguese mathematics courses – students are "left to their own devices" until the first set of examinations. Most UK mathematics courses do involve regular weekly work during the first year, set and marked by tutors. This practice does not continue into subsequent years on a systematic basis.

Students' expectations concerning some aspects of the conditions of learning highlight areas where their expectations are not realised. Portuguese students initially expect to understand readily the material presented in lectures (UK students less so), and a considerable majority anticipate that there will be at least as much help available as at school, if not more. They expect to participate actively during lectures.

Many students thought they would find university mathematics difficult (although significantly fewer in Portugal than in the UK). The proportion who felt that would enjoy mathematics less than at school was small initially but increased substantially after their first year experience. They expected to have to give more careful and detailed explanations in their solutions, but many reported subsequently that this had not been the case overall.

Our enquiries about topic difficulty indicated that they anticipated finding Proof the most difficult of the topic areas we listed. What is perhaps alarming is that both in Portugal and in the UK the reported degree of difficulty of Proof increased after the first year experience. It appears that whatever encounters with Proof they have during the first year have a negative effect. This needs careful attention on the part of lecturers.

It is clear that in many cases student expectations as expressed at the beginning of their course are in some respects a product of attitudes formed during their schooldays. In those cases where these attitudes cause problems of learning research needs to be undertaken into the sources of these attitudes. For example the high failure rate among first year Portuguese students may be linked to the fact that repeating years of the course is a well accepted phenomenon, although this relationship needs further investigation. Some informal data collected suggested that even at the beginning of the course few students expect to complete in the minimum time (5 years). Responses of 7 or 8 years were common, and a few students suggested that they expected to complete the course in 10 years!

References

Comissão de Avaliação Externa das Licenciaturas em Matemática. Relatório Final: Fundação das Universidades Portuguesas – Conselho da Avaliação (1998).

Daskalogianni, K., & Simpson, A. (1999). The formation and effects of attitudes towards mathematics in upper sixth form students. In the *Proceedings of the British Society for Research into the Learning of Mathematics*, (Nov. 1999, pp. 7-12)

Daskalogianni, K., & Simpson, A. (2001). Beliefs overhang: The transition from school to university. In the *Proceedings of the British Society for Research into the Learning of Mathematics,* Vol. 2, (pp. 97-108).

Daskalogianni, K., & Simpson, A. (2002).“Cooling-off”: The phenomenon of a problematic transition from school to university. In the *Proceedings of the second international conference on teaching mathematics at the undergraduate level,* Crete.

Dearing, R. (1997). *Higher Education in the Learning Society - Report of the National Committee of Enquiry into Higher Education.* HMSO.

Hanna, G. (2001). Proof, explanation and exploration: An overview. *Educational Studies in Mathematics, 44*, 5-23.

Rego, A., & Sousa, L. (1998). *Panoramas da Universidade de Aveiro: Reflexões sobre os seus actores* Universidade de Averio.

Santos, L. (2001). *Adaptação Académica e Rendimento Escolar (Estudo com alunos universitários do 1º ano)* Braga: Universidade do Minho.

UNITE/MORI (2002) *The Student Living Report 2002.* (This report can be downloaded from http://www.unite-group.co.uk/scripts/site/index.asp)