Improving University Teaching and Learning

PROVIDING STUDY SKILLS ADVICE TO THE MATH-ANXIOUS: DEVELOPING A MODEL FOR EFFECTIVE TEACHING PRACTICE

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Abstract

This paper is the result of a pilot study to motivate and help structure the development of a model for effective teaching practice when providing academic assistance to math-anxious university students. Students seeking academic skills advice for math-related study problems are identified within two broad categories, one of which contains a sub-category of students who are at most risk of academic failure or withdrawal. A range of issues is considered via a literature review and examination of actual case notes and summary data. A client student profile is identified and the learner/teacher styles and interaction are reported. Finally, "numerosity", numeracy, and the connections between language and math anxiety are briefly discussed.

1. Introduction

This pilot study aims, ultimately, to develop a model for assisting students to better cope with math content in university teaching when they have little formal math background and/or (in particular) they experience math anxiety. Excellence in tertiary education must necessarily be predicated on the existence of an environment that will enable all students to realise their maximum academic potential. A significant part of that environment lies in the provision of support services and this paper looks at some aspects of delivering academic skills advice in the areas of math and numeracy to students from all levels of university and from any faculty. Section 2 consists of some observations and discussion drawn from the author's experiences working with students in this regard and thus provides a context that serves to motivate the study.

Section 3 comprises a review that identifies and discusses briefly some of the literature that has dealt with these and related issues. Pertinent factors considered include:

- the concept of 'generic attributes'
- differences between the separate perceptions of students and teachers and student/teacher interpersonal behaviour;
- student motivation and help-seeking behaviour;
- conceptions of learning; and
- the multidimensional nature of math anxiety.

Section 4 indicates the methods used to explore empirically the relevance of matters raised in the previous sections (to the extent that they are manifest in the course of providing math-related academic skills advice to students at Flinders University). The results are reported in section 5 and discussed in section 6.

2. Background

Some students (a small number) seeking assistance for math-related study problems do so on referral from topic lecturers or tutors who have recognised that the student is experiencing some difficulty that lies beyond the normal scope of topic content. But most students are self-referrals and, by the author's observations, they tend to fall into two broad yet distinct categories:

- effective, generally successful students who want to do even better; or
- students who are struggling to cope with aspects of their topic.

As distinct as these groups may seem, it is the author's experience that they nonetheless have much in common and teaching practices and strategies which prove effective with one group can often be applied successfully to the other, or at least may suggest analogous approaches. This would appear to indicate that teaching activities and interactions that promote student development are largely independent of the level and detail of the specific content with which students are contending. That is, almost regardless of the subject matter, there are underlying cognitive and emotional factors that primarily determine successful learning experiences. In the area of math and numeracy issues this seems to be particularly well illustrated and it becomes even more apparent when advising students who find they have to deal with math content in non-math topics.

The first of the above groups tends to consist of 'high-achievers' - students who are interested in developing or refining specific technical skills. They may have grasped most aspects of some concept but find that the more subtle points elude or confuse them; or perhaps they've found that they know *what* to do, but they don't understand *why* they're doing it. Another way they seek to improve their performance is by acquiring more effective or efficient strategies, either directly involving content material or broader study issues such as organisation, note-taking, review and revision, exam preparation and so forth.

The second group comprises what may be called 'battlers' - students who are experiencing varying degrees of concern over their ability to cope with topic content. This group can be further divided into two sub-categories:

- 'top-up' students who are generally effective in their particular course but who need either to fill in key background knowledge or skills, or additional help to master new content that hasn't 'clicked'; or
- 'at-risk' students who have varying degrees of distress (which can at times be extreme) due to their inability to cope with most or all of the topic content relating to math and numeracy issues. This is so particularly when the difficult material is encountered in what the students understood was a non-math topic or that supposedly had no pre-requisite math skills. The vast majority of these students experience at least some degree of math anxiety.

This final sub-group is the most significant for the purposes both of the current study and for the advisor in that the greatest opportunity to 'make a difference' also presents the greatest challenge to effective teaching practice. These students tend to be those at greatest risk of failing or withdrawing from a topic, possibly even leaving university and abandoning tertiary education. The author has observed that, in many respects, they often identify themselves as victims whose math anxiety was inflicted on them by bad experiences with math during their primary or secondary school years. For several years, the author has been involved with the Flinders University of South Australia's Foundation Course - the university's alternate entry program. Participants represent a broad cross-section of the general community in terms of age distribution and socio-economic status. The majority have been educationally disadvantaged and in many cases they are the first in their family to come to university. Anecdotal evidence from these students illustrates the extent to which innumeracy is endemic within the wider population – a large majority of Foundation Course students admit to some degree of math anxiety or will say they "hate math" or were "never any good at it". Each year, they are asked to report on their worst math experiences and the most distinct aspect of the responses is the individuality of each student's handwriting – otherwise, essentially the same story is told repeatedly and it invariably involves bullying and humiliation in various guises. A nursing student recently sought advice from the author because she was "terrified" of the drug calculation examination she must pass next year. In talking about her background she said she had suffered school-phobia, attributed to the impact of a particular math teacher who, she said, "...was a big man who stood over me with a loud voice and who used math as a punishment."

Given such a background, these students thus present the greatest opportunity to 'make a difference'. They form a *focus group* that consists of those who, if they can be helped, can be helped most. As such, this focus group also presents the greatest challenge to effective teaching practice because the high-achievers are likely to reach successful outcomes with or without extra assistance and top-up students are likewise in a relatively strong position because they are aware, at least, of their own skills and limitations. The former have already demonstrated effective learning strategies (at least in so far as they are able to satisfy assessment criteria) and they're sufficiently well motivated and self-directed to pursue a range of strategies to fill in the gaps in their knowledge and understanding – as are the latter.

To be effective with focus group students, the advisor needs to facilitate new levels of understanding - new ways and means for these students to approach their difficulties from a different perspective. Figure 1. illustrates the challenge: the student is surrounded, overwhelmed, by the task at hand: acquiring specific skills; dealing with math content; developing effective learning strategies. But there is a siege. The needed insights have to be facilitated from outside and they are blocked by the barriers of anxiety, negative beliefs and stereotypes. There-in lies the challenge - effective teaching strategies for these students go well beyond the usual scope of math teaching. Before the advisor can even begin to address specific content and techniques, it is necessary to uncover the nature, scope, and source of this outer barrier. The wall has to be breached somewhere.

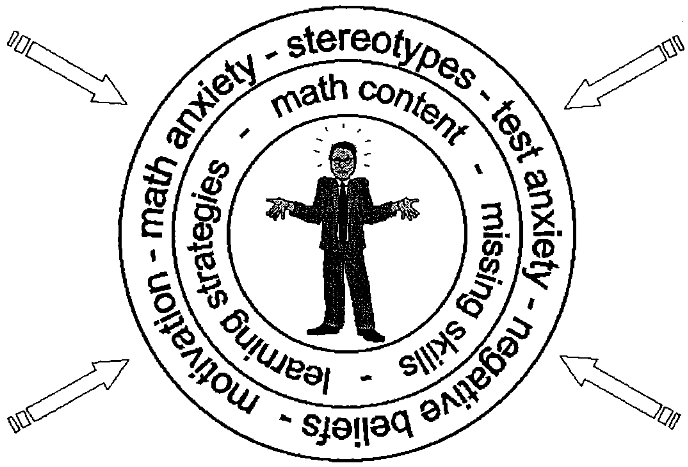

Figure 1

Many of these students will say at the outset that they "hate math", either because they are "no good at it and never have been" or because of negative experiences. They tend to be quite entrenched in their views and they may even be hostile and resentful at being confronted with the material since they feel they are being forced to do something they "know" they're "no good at." Often, they are looking for help but, paradoxically, not expecting to change their perceptions of math and their perceptions of their own ability to do math. And this is the first task - to adopt an approach that allows them to admit the possibility that their negative views, no matter how valid they may once have been, need not be absolute and insurmountable. From this, it appears reasonable to assume that the students' and the advisor's perceptions of their respective roles, the interaction between them, and the effect of these on student attitudes are particularly critical factors for successful outcomes and should, therefore, be examined carefully.

The purpose of this study is to examine a range of issues associated with providing study skills advice to members of the at-risk group (particularly those who experience math anxiety). This is to be regarded as a prelude to developing a useful model for assisting students to better cope with math content in university teaching when they have little formal math background, experience math anxiety, or otherwise find themselves out of their depth. It is reasonable to suppose that many of the elements that affect student performance are not confined to students with math difficulties and so it is pertinent to look more broadly within available teaching and learning literature.

3. Literature review

Cummings (1998) reports on identifying generic student attributes and how they should be assessed and reported and identifies five essential questions in this regard:

- How to describe each generic attribute?
- How to incorporate generic attributes into the curriculum?
- Can each generic attribute be measured?
- If a generic attribute can be measured, how should it be assessed?
- How should the assessment result be reported?

The paper lists three trends driving the search for measurable generic attributes and argues that there is considerable similarity of generic attributes across Australian universities. Further work is identified as being needed to incorporate generic attributes in the curriculum. In earlier work, Cummings and Ho (1996) concluded that the generic attributes identified by employers, secondary-, vocational-, and tertiary-education sectors bore a “remarkable similarity”.

Croft (2000) similarly reports an increase in the number of employers carrying out pre-employment psychometric testing with such tests often including numerical reasoning, numerical analysis, or simply basic numeracy. Citing students of humanities or social sciences as examples, Croft points out that they have probably had little or no opportunity to practice numerical skills since GCSE examinations at school (UK) when they were 15 or 16 years of age. Referring to the mathematics learning support centre, the establishment of which is the main theme, the paper states that "the Centre has made a valuable contribution to the employability of students in the university and helped to develop their confidence as they enter the workforce." By so doing, Croft appears to suggest that generic attributes necessarily should encompass numeracy issues.

Lake (1998) considers a "lack of alignment between the student's assumptions, motives, intentions and previous knowledge and those of academia" as important factors in student withdrawal from university. He identifies significant shifts in the size and nature of university "clientele" as requiring universities to respond to a new set of assumptions and the qualitative changes occurring in tertiary education. More particularly, Lake points to the substantial increase in mature age students, including many for whom normal entry requirements have been waived together with new groups of 'disadvantaged' students (citing Richardson, 1994). Both the nature and the needs of such students is seen as substantially different to those of the more traditional student body and Lake's paper reports on the successful introduction of a topic ('A120') designed specifically to respond to the reported changes. Describing what is called a "constructively aligned approach", he indicates that "students (do) not recognise their need" and so a main feature of A120 was the merging of content with process throughout so that students would have the opportunity to develop generic skills. Students participating in A120 were surveyed and 75% of the respondents remarked on the value of developing specific study skills via their integration with content.

Marton *et al.* (1993) identified six qualitatively different conceptions of learning:

- increasing knowledge
- memorising and reproducing
- applying
- understanding
- seeing something in a different way
- changing as a person

The first five, having been identically identified previously (Saljo, 1979), are given a more precise characterisation. The structure of the "what" of learning is separated into external and internal horizons. The external horizon represents the personal context of the learning experience while the internal horizon represents the learning process via a "consumption metaphor". The paper notes that referential aspects of learning relate directly to both the purpose for which learning is sought and the particular conceptions of learning that learners associate with that specific purpose.

Biggs (1999) refers to "aligned teaching systems" i.e. teaching objectives that express the understanding wanted by teachers from students, teaching contexts that encourage students to undertake learning activities to attain that understanding, and assessment tasks relevant to those outcomes. Two examples of "aligned teaching systems" are described: problem-based learning (PBL) and the learning portfolio. In this context, Biggs discusses student ability and teaching method, constructivism and phenomenology, and levels of teaching competence. In the latter, three levels are considered:

- what the student is
- what the teacher does
- what the student does.

The first item addresses student differences (from a teacher's perspective) while the third focuses on what learning is or is not occurring (by virtue of students' actions) and thus links the meaning of "understanding" with teaching/learning activities (TLAs) required to reach that understanding.

How students approach learning and then derive their learning objectives has provoked a considerable body of research literature. Of particular note is the ground breaking work of Marton and Saljo (1976) which distinguished between "surface" and "deep" approaches. Felder (1993) notes what he calls "dimensions of learning style" which can, in part, be defined by answering five questions addressing, respectively:

- the type of information preferentially perceived by the student - *sensory* vs *intuitive*
- modality of information perception - *visual* vs *verbal*

- method of information organisation - *inductive* vs *deductive*
- preferred style of information processing - *active* vs *reflective*
- progress toward understanding - *sequential* vs *global*

Felder (*op. cit.*) advocates a mixture of teaching styles in science education and highlights mismatches between the teaching styles traditionally prevalent in most science courses and the learning styles of the majority of students. Felder and Soloman (u.d.) are developing an instrument, the Index of Learning Styles (ILS), to assess preferences on the five dimensions of Felder's learning style model.

Zadnik *et al.* (1999) report on the experience of teaching first year university students the concept of atomic and quantum physics by other than the traditional methods ordinarily used. The work was motivated by previous observations (Bethge, 1988) that when students learn first via classical descriptions/approximations they tend to retain and use these conceptualisations in preference to the more appropriate models of quantum mechanics. In a not dissimilar vein, Kessell (1997) notes that "many undergraduate science and engineering degrees are so packed with 'facts', 'technical detail'... that they do not address adequately such basic issues as creative thinking and problem solving skills". Kessell goes on to support the opinion (Perry, 1988) that students' views of knowledge can evolve along a "learning scale" from merely acquiring facts to finally realising that "knowledge and understanding is [*sic*] challenged constantly". The students come to recognise learning as a dynamic process both intrinsically and extrinsically.

Taylor *et al.* (1999) address the central question of whether there is a gap between students' perceptions of their studying/learning approaches and lecturers' perceptions of the studying/learning approaches which they facilitate in their students. They show that there are significant discriminators between these two sets of perceptions and identify a mix of specific items emerging from the "deep", "surface", and "strategic" approach scales used in the study. The work employed the Revised Approaches to Study Inventory (RASI), (Tate and Entwistle, 1995), a 44-item, 6-dimensional questionnaire. Students and academic staff were sampled and profiled. In a second stage, a new instrument, 'Approaches to Teaching', was used for the purpose of "identifying how lecturers perceive the dimensions of their teaching effectiveness provide a context for students' teaching/learning approaches".

Rickards and Fisher (1998, 1996) found that there were differences in teachers' and students' perceptions of teacher-student interpersonal behaviour (with teachers tending to have more positive perceptions), and that there were differences between teachers' *actual* versus *ideal* perceptions. In these studies, Rickards and Fisher utilised the 'Questionnaire on Teacher Interaction' (QTI) instrument to gather students' and teachers' perceptions of their interaction. The QTI was available in three forms, including an Australian version. Although the 1998 study examined secondary education, the reports suggest the approach may be adaptable to tertiary teaching and learning. The authors conclude that the QTI may be used by teachers as an efficient [and, hopefully, effective] tool for self-reflection.

Karabenick and Knapp (1988) examined the "functional relation between the need for academic assistance and help seeking... in a university setting." Their results support the intuitive notion that students who most need help are least likely to seek it. They note that, "repeated lack of success is likely to result in attributions to low ability, and stable low ability attributions engender expectations of future failure... [and] may also be accompanied by negative emotions such as sadness, guilt, embarrassment, hopelessness, and resignation, and... feelings of helplessness... [This] would lead to low task persistence and withdrawal."

Ryan and Pintrich (1997) explored motivational and attitudinal factors that explain reported help-seeking behaviour in early adolescents. Investigating motivational influences on help seeking behaviour, they concentrated on perceptions of cognitive and social competence, achievement goals, and attitudes toward help seeking. They found that students are more likely to avoid seeking help when they are unsure of themselves, whether cognitively or socially. They differentiated achievement goals as task-focused (learning, as an end in itself), extrinsic (reward/punishment), or relative-ability (comparison with others) and noted that, "The pursuit of extrinsic goals seemed to exacerbate the vulnerability of students with low perceptions of their own cognitive competence." Here, vulnerability refers to apprehension about the reactions of others in response to requests for help.

Brown (1997) reported, "...mathematics has a special difficulty in popularisation... in part traceable to a lack of clarity in the mathematical community, by both researchers and teachers, as to the nature of mathematics itself, and so to a lack of clarity about conveying this to the general public." Further, "...the public and Government are in general unclear as to what mathematicians produce and how valuable is what they produce. Mathematics undergraduates, even very able ones, are often unclear that any research goes on in mathematics." And, "...students of mathematics are starved of (...) an understanding of the place of mathematics as a human endeavour." Brown describes a widespread lack of understanding of mathematics within the community-at-large and even within the education sector and refers to efforts being made to address this by such as the Centre for the Popularisation of Mathematics, University of Wales (Bangor).

Bessant (1995) emphasises that mathematics anxiety is multidimensional. Indicating the confusion over its meaning, Bessant related this to its similarity with other notions in the affective domain and suggests that math anxiety and attitudes towards mathematics are interconnected. Tabulated results show significant differential interaction between learning approaches ("*Deep-Achieving Approach, Achieving Motive, Surface Motive, Achieving Strategy, Surface Approach, Surface Strategy, Deep Strategy*") and specific types of math anxiety ("*General Evaluation, Everyday Numerical, Passive Observation, Performance Anxiety, Math Test Anxiety, Problem Solving Anxiety*").

In summary, these readings indicate the existence of several factors that are pertinent to the present study. They include:

- generic attributes of students who seek assistance in this area;
- the nature and needs of students in the dual contexts of their personal development and the criteria by which their academic performance is judged;
- how students approach learning (particularly learning in areas where they perceive content to be especially difficult) and derive their learning objectives;
- how instructors/advisors approach learning and derive their teaching objectives;
- disparities between students' and advisors' perceptions of their respective roles;
- the nature of the interaction between students and instructors/advisors and its effect on student attitudes.

It seems clear that, to develop a useful model to assist students such as those in the at-risk sub-group, it is necessary to have an understanding of these factors and, particularly, their role and relevance with respect to the focus group of at-risk students.

4. Methods

In plain terms, we need to understand the students and what they want and need in the context of their individual problems. At the start of a first consultation, students are asked to complete an index card. This records contact details together with their faculty, year level, means of university entry (school leaver or not), first language, means of referral, and area of study. The advisor then engages the student in discussion to determine the reason for attendance, background (an overview of previous schooling and school experiences, looking for strengths/weaknesses across the curriculum as well as issues relating to family, peer, and teacher interactions), and goals. The aim is to obtain a broad diagnostic picture, a scenario that identifies the student in an educational and social context and provides a basis for assessing the most appropriate means by which to address the student's specific concerns. This first discussion is particularly vital in establishing the style and nature of the student-advisor interaction, building mutual trust and confidence.

Overall, the intention is to identify what works and what does not. The approach adopted here has three components: (i) construction of a client profile; (ii) discussion of approaches to learning/teaching adopted by students and the advisor respectively; and (iii) consideration of the student/advisor interaction. The latter two points are considered in the particular context of math anxiety, with the emphasis being on focus group students.

Point (i) was established by using case notes and workload statistics held by the Flinders University Study Skills Centre to construct a profile of the 'typical' student client. The data span several years and provide demographic information which includes gender, age, method of university entry (school-leaver / non school-leaver), and faculty/degree/topic. In addition, the records provide some indication of qualitative key factors for content, learning styles, and attitudes which, though difficult to extract, point to various generic attributes. These are discussed briefly. Points (ii) and (iii) derive from the author's experiences with students in the focus group. The present discussion will aid the development of appropriate instruments for a more extensive study. viz.: A full examination of point (ii) is to be undertaken by survey using a questionnaire based on the 'Revised Approaches to Study Inventory' (RASI) of Tate and Entwistle (cited in Taylor *et al.*, 1999), the 'Index of Learning Styles' (ILS) of Felder and Soloman (1999)., and the 'Approaches to Teaching Inventory' (ATI) of Prosser and Trigwell (1999). Similarly, a full examination of point (iii) is to be carried out by survey using an adaptation of the *Questionnaire on Teacher Interaction (QTI)*, drawing on the work of Rickards and Fisher (1996, 1998) who have modified the QTI for use in Australia and at the tertiary level.

5. Results

5.1 Client student profile

Teaching and research at Flinders University are carried out in 21 individual schools and departments administered by four faculties:

- Health Science;
- Education, Humanities, Law and Theology;
- Science and Engineering and;
- Social Sciences.

Table 1. Relative proportions of client students attending for academic assistance with math-related study problems.

RELATIVE PERCENTAGES	EHLT		Health Science		Science & Engineering		Social Science		ALL
All students	8%		16%		37%		39%		100%
Male	2%	25%	4%	25%	16%	42%	16%	40%	37%
Female	6%	75%	12%	75%	22%	58%	24%	60%	63%
School leaver	0%	0%	8%	50%	10%	26%	2%	5%	20%
NSL	8%	100%	8%	50%	27%	74%	37%	95%	80%
Male school leaver	0%	0%	0%	0%	4%	11%	0%	0%	4%
Male NSL	2%	25%	4%	25%	12%	32%	16%	40%	33%
Female school leaver	0%	0%	8%	50%	6%	16%	2%	5%	16%
Female NSL	6%	75%	4%	25%	16%	42%	22%	55%	47%

Table 1 summarises the relative percentages of client students attending the Study Skills Centre for assistance with math-related study problems (the data span years 1997 to 2000). The same data are represented graphically in Figure 2. Not surprisingly, students from Science and Engineering, and Social Sciences dominate the numbers. The 16% (overall) from Health Science mostly comprise 3rd Year Nursing students.

Looking at gender across the board, the female to male ratio is about a 60/40 mix (i.e. 3:2) with the figures biased, of course, by the contributions of the two dominant faculties. The greater representation (3:1) of females within the other two faculties reflects the larger number of female students undertaking nursing and teacher education.

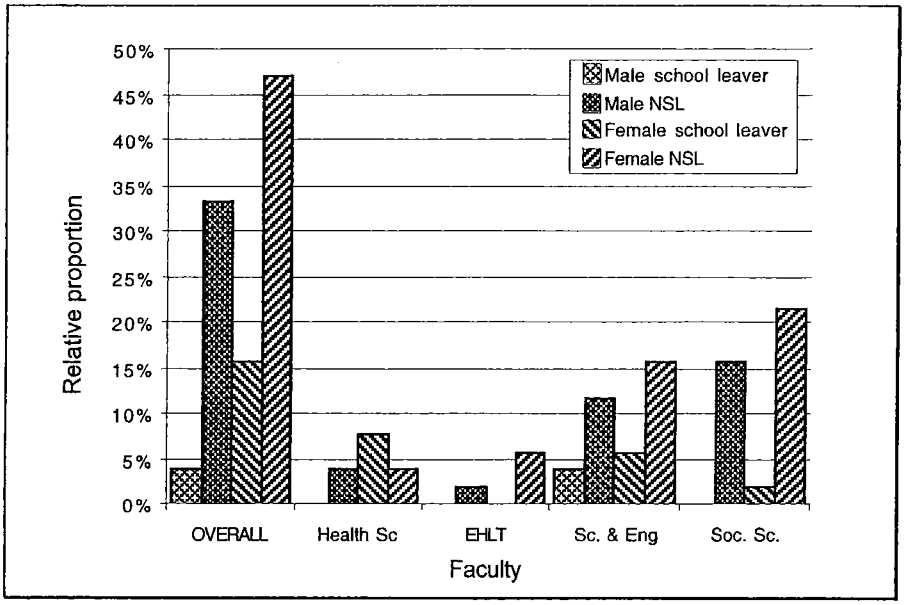

Figure 2. Relative Client Student Distribution by category, proportioned overall and by faculty.

Concerning means of entry to university, these are broadly classified into school leavers and non-school leavers (NSL). NSL students are those who have *not* entered tertiary education directly from secondary school. As such, they comprise those who chose to not attend university immediately after completing their secondary education (though sufficiently qualified to do so) and also those who gained entry to university by alternate means, such as mature-entry provisions and schemes like the Flinders University Foundation Course. Here, the overall ratio is 4:1 in favour of NSL students but there are marked differences between faculties. Within Science and Engineering the ratio becomes a slightly more balanced 3:1 whereas for Social Science it is almost 20:1. The difference may be explained by considering the likely expectations of students entering university. Those who choose to undertake a degree within the 'hard sciences' are perhaps more oriented towards technology. They would likely have anticipated at least some mathematical content and may be expected to be better equipped with basic numeracy and math skills. However, many (or even most) students entering the social sciences appear to anticipate encountering very little substantial math content and most initial reservations in this regard tend to be assuaged by statements in topic descriptions such as "no previous knowledge is assumed". These students tend to be rather less well equipped with basic numeracy and math skills than their Science and Engineering peers. In each case, the dominance of NSL students may commonly be attributed to a lack of recent exposure to mathematical tasks and formal instruction and practice. Interestingly, the 1:1 ratio for Health Science indicates that means of entry is unlikely to be a factor for these students. However, this may be seen, also, as a consequence of expectations, together with the observation that the concerns of such students are dominated by arithmetic (numeracy) and problem-solving skills rather than the abstractions of algebra and methods of 'higher' mathematics. The corresponding data for EHLT students may not be truly representative of the actual situation because of the limited number of client students from that faculty and so it is not realistic to draw any conclusions here with a reasonable degree of certainty.

In combination, male school leavers are conspicuously under-represented (0%) in all but Science and Engineering. The obvious explanation that such students tend to not need help should be viewed with suspicion, as there appears to be no literature to suggest that this is reflected in pass rates. Rather, to the contrary. One conjecture that may be more plausible is the reticence of young males to *seek* help, particularly those who need it the most (*à la* Karabenick and Knapp, 1988; also Lake, 1998). Female school leavers within the Social Sciences are also clearly under-represented (5% compared to 16% overall) and it would appear that a likely conjecture here is, again, reticence to seek help. In contrast, female school leavers within Health Science are substantially *over*-represented (50% compared to the overall 16%). This may be understood in the context of the course of study for these students - almost exclusively, they are 3rd Year Nursing students who *must* come to terms with numeracy skills sufficient to meet the strict course requirements of 100% accuracy on a final drug calculations test. If they fail to meet the standard, they fail the course. The stringent criterion ensures that help *is* sought when it is needed.

Looking next at age distributions, Figure 3 shows the median ages of: all client students; male school leavers and NSL's; and female school leavers and NSL's. As before, each student category is further identified by faculty.

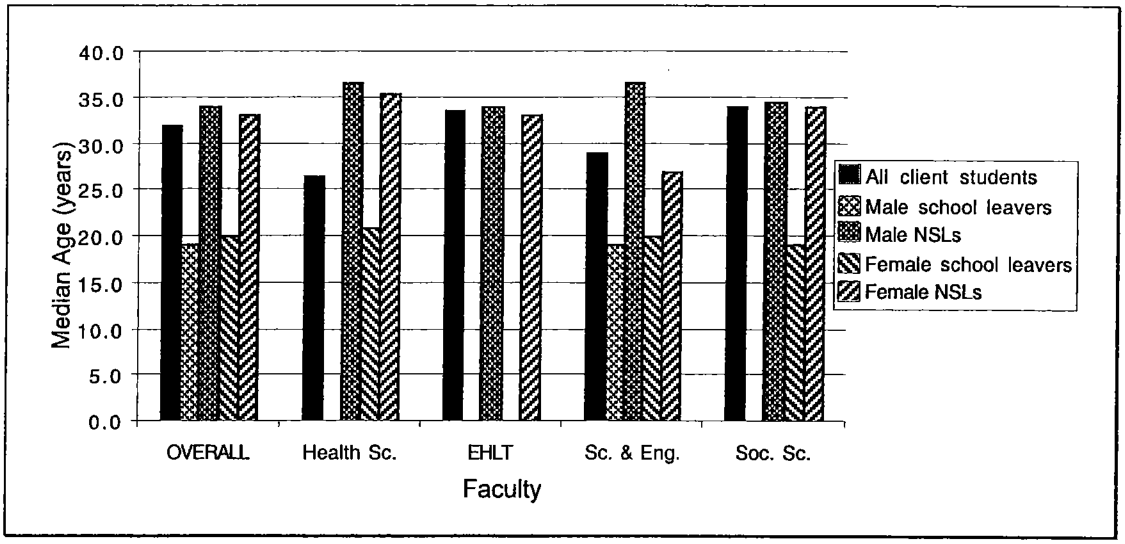

Figure 3. Client Student Median Age Distribution by category, overall and by faculty.

For NSL students, generally the median age for males is marginally greater than for females, though the difference is markedly greater (of the order of ten years) within Science and Engineering. This age/gender difference may be explained at least in part by different life experiences for males and females. Reports from female NSL's indicate a tendency to enter science-related study out of interest, desire for a career change, or to gain qualifications to advance to professional standing from a more support-based role. On the other hand, many male NSL's have actively engaged in technical occupations over some years, perhaps with notable success, to reach a point where they need to acquire formal qualifications in order to ratify their practical expertise and gain full acceptance as a professional within their chosen (or related) field.

For school leavers, as expected there is no significant age discriminator with the exception of client students in Health Science where the median age is a little higher than elsewhere. The certain explanation is that this reflects the dominant presence of 3rd Year Nursing students, in contrast to the (predominantly) 1st Year students otherwise seen.

To summarise, Table 2 provides a ranking of the various profiles according to the relative proportions supplied by each criterion together with the relevant median ages. This shows that about two-thirds of the client students are likely to be 'thirty-something' non school leavers studying within Social Science or Science and Engineering, in the ratio of about 4:3, with females exceeding males in number also in the ratio of about 4:3.

Table 2. Student profiles ranked by relative proportions per criterion (male/female, school-leaver/NSL, faculty).

RANKED PROFILES (median ages)		
1	22%	34 y.o. female NSL in Social Science
2	16%	34 y.o. male NSL in Social Science
2	16%	27 y.o. female NSL in Science & Engineering
3	12%	36 y.o. male NSL in Science & Engineering
4	8%	21 y.o. female SL in Health Science
5	6%	20 y.o. female SL in Science & Engineering
5	6%	33 y.o. female NSL in EHLT
6	4%	19 y.o. male SL in Science & Engineering
6	4%	37 y.o. male NSL in Health Science
6	4%	36 y.o. female NSL in Health Science
7	2%	19 y.o. female SL in Social Science
7	2%	34 y.o. male NSL in EHLT

5.2 Approaches to learning and teaching

Almost exclusively, interviews with, and experience of, focus group students reveal a range of common characteristics that are largely independent of the specific topic-related difficulties that prompt them to seek help and also of their age, gender, faculty, and means of university entry. These are:

- *Confusion* - they are unclear about what is required of them, tending to over- or under-estimate the difficulty of subject material, with little insight about the extent of their relevant prior mathematical and other knowledge and pertinent skills. Perhaps significant as a source of confusion is that, not uncommonly, they do not know *what* they 'don't know'. They are apt to be poorly organised with their notes and make scant use of text books and other resources;
- *Lack of confidence* - repeated lack of success seems to manifest (understandably) in low self-esteem, which may or may not impact on other endeavours. Often, this is accompanied by strong negative emotions of embarrassment, self-deprecation, and helplessness (reported also by Karabenick and Knapp, 1988). Thus low expectations are common, as are lack of persistence and a temptation to withdraw. Many have delayed seeking help and regard the same as a final attempt before giving up; as such, frequently they have little initial interest in attempting to acquire understanding and express hopes of acquiring a 'magic bullet' to subvert their problems;
- *Negative perceptions* - of themselves and their cognitive competence, of their lecturer(s) and the topic organization. This may extend to their perceptions of the reactions of their peers, lecturers and tutors, and family. As with the previous point, the negative perceptions contribute to low self-esteem and all that follows;
- *Lack of strategies* - more than straightforward general study skills and strategies (which may or may not be part of the individual experience), they are largely devoid of strategies to help them navigate out of their situation. Moreover, though they may be very competent problem solvers in other ways, their confusion and negative perceptions and emotions are too strong an influence in *this* context - a fact which (for Science and Engineering students in particular) is often aggravated by a lack of attention to creative thinking and problem-solving skills (Kessell, 1997);
- *Assessment-driven motivation* - either as a feature of their usual approach to learning or as a consequence of unsympathetic or indifferent attitudes toward mathematics, their main concern lies with acquiring the minimum skills necessary to satisfy assessment criteria. This may stem from a lack of belief in their capacity to attain a deeper understanding, at least as an achievable outcome within the constraints imposed by typical undergraduate workloads. In this sense, these students pursue the 'extrinsic goals' described by Ryan and Pintrich (1997), with all the attendant consequences and implications.
- *Narrow focus* - there is a strong tendency to see mathematics as 'different' from other intellectual activities. Consequently, their capacity to generalise is limited, at best, and they display little facility to synthesise knowledge connections to aid their understanding or develop coping strategies.

- *Little or no appreciation of the concept of mathematics as language* - most will readily acknowledge that mathematics abounds with specialised terminology, much of which involves words whose definitions are much narrower than their common, or everyday, usage (thus acquiring the status of jargon). However, rarely will students show an awareness or appreciation that mathematics proper *is* language. That is, they accept that specialised language describes mathematical concepts but fail to recognise the converse, that *mathematics language describes specialised concepts.*

It is common within teaching and learning literature to associate these characteristics with shallow, or surface, learning styles. Their presence may indicate a lack of metacognitive skills, avoidance behaviour, and extrinsic goals as discussed by Ryan and Pintrich (1997). They may, of course, be found in students outside the focus group. In such cases, it is usually a relatively straightforward matter to give assistance by helping students to identify where, when and why they experienced difficulty and exactly what triggered the problem. Often the obstacle can be overcome by introducing alternate strategies. However, taken in conjunction with math anxiety (or worse still, math phobia) the presence of such characteristics presents the advisor with a considerably greater challenge. It is here that an appreciation of the profiles reported in 5.1 proves valuable since the vast majority of tertiary students requiring this form of assistance are mature students (i.e. NSL's). Although they may be more entrenched in their attitudes, beliefs and behaviours than their younger peers, they are also likely to be more motivated and committed to overcoming their difficulties – in part because of the personal struggle to enter university and consequent desire for success to justify that struggle; in part because of their typically strong sense of direction and purpose. Moreover, they bring to their studies a wealth of prior experience that provides the advisor with a rich source of material to draw upon in looking for analogies to aid understanding and illustrate successful strategies.

5.3 Student/Advisor interaction

The greatest disparities between students' and advisors' perceptions of their roles are the student's desire for 'quick fix' solutions versus the advisor's aspiration to imbue deeper understanding, and the student's extrinsic, assessment-driven goals versus the advisor's goal of promoting intrinsic goals and self-directed learning. The most effective teaching practice occurs when the teaching style and quality of the student/advisor interaction promote a high degree of mutual respect and trust that moderates the disparities and allows the advisor and the student to negotiate the means to address the problems *together* with some sense of equality.

Students may or may not admit ownership of their problems but it is essential that they accept their share of responsibility for the problem solving process and claim at least a large portion of ownership of successful outcomes. That is not a profound statement but, rather, a reflection of conventional wisdom. The advisor's primary objective must be to address the first three dot points above (confusion, lack of confidence, and negative perceptions) by guiding the student appropriately. This might be achieved by explaining and demonstrating how the context and methods of mathematics are revealed through its application as *language*, mapping these onto concepts and language with which the student is otherwise familiar and confident.

6. Discussion

We have looked at the range of students seeking assistance for math-related study problems, concentrating on a focus group of 'at-risk' students, many of whom experience math anxiety (or worse). We have looked, also, at a range of issues affecting those students and the delivery of effective study skills advice, first by literature survey and then by examining case notes and workload statistics held by the Flinders University Study Skills Centre. In particular, the issues for consideration were: generic attributes and the needs of client students, student/advisor approaches to learning and teaching, disparities between students' and advisors' perceptions of their roles, and the interaction between them.

Numeracy skills are taught mostly during primary and early secondary education and honed by experience and practice. NSL students, though further removed from formal instruction than school leavers, may draw on life experience for much of that practice. School leavers may lack the same degree of practice, but their original instruction is a more recent experience. In each case, the respective competencies appear to be both similar and relatively stable, in that the range of difficulties these students come across tend to correlate with reported difficulties stemming from their earlier school experiences. Many animals display 'number sense' and possess some capacity to perceive numerical quantities ("numerosity" or "numerousness"), a topic richly discussed by Dehaene (1997). Numerosity is a 'fuzzy' sense, in contrast to the strict precision of arithmetic and whereas the former is innate the latter is an invention, the mastery of which is necessarily to be learned. The author's observations and experience suggest that negative early learning events involving numeracy may signal the beginning of math anxiety. Increasing lack of confidence may engender avoidance of further learning, cause anxiety to escalate, and impede pupils' progress in the abstraction of generalized arithmetic, i.e. algebra, and other math endeavours. Without such progress, there could be little scope for the development of an appreciation of mathematics in any broad sense.

The Attitudinal Measures of Mathematics Enjoyment and Valuation employed by Bessant (1995) are highly relevant to the characteristic of *narrow focus*. Three dimensions identified among these measures differentiate the scientific and educational value of mathematics and deal with the overall value of mathematics to people and to the advancement of society. The problem of narrow focus is understandable and reflects the widespread lack of understanding of mathematics (Brown, 1997). Clearly, 'narrow focus', in the sense of limited ability to generalise or synthesise, is not confined to students who experience difficulty with mathematics. However, in the context of their particular struggles, the lack of clarity described by Brown undoubtedly compounds their problems.

For the advisor, it is frequently possible to demonstrate that a student already possesses greater abilities than those demanded by the mathematics since, by appreciating the language aspect of math, each new equation may be seen to communicate new ideas and assist in the construction of knowledge. By actively engaging in this process, the student acquires a much broader range of strategies, may discover a stronger motivation than mere extrinsic goals, and gains a wider focus that permits a better understanding of the value and place of mathematics.

Further progress towards developing a model for assisting math-anxious students to better cope with math content in university teaching may well be promoted by concentrating on the connections between language, negative early learning experiences, and math anxiety. And by considering the role of public awareness of mathematics, including the means by which public awareness of the value and purpose of mathematics (and, more generally, the 'hard' sciences) may be increased.

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