The Transition from Secondary School Mathematics to University Mathematics

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Making the transition from secondary school to university is a challenging hurdle for most first year students, both personally and academically. This investigation is focussed on the influence of affective variables on students as they make the transition from second level mathematics to university mathematics. Gill and O'Donoghue at the University of Limerick carry out diagnostic testing of first year students in service mathematics courses on a yearly basis. Results have shown over 30% of students in the database have scored 20 (or below marks) out of 40. The authors suggest the Leaving Certificate ordinary level maths syllabus is not adequate preparation for service mathematics courses. Such findings suggest the need for assessing early undergraduate transition to university life and address the 'gap' between second and third level mathematics. This paper presents the findings, conclusions and recommendations with regard to exploratory research carried out by the author in an Irish context. A preliminary quantitative study in the form of a questionnaire based on attitudinal scales was undertaken at third level to investigate the influence of affective variables on students' mathematics learning in the transition process. Questionnaires were distributed to three groups of first year service mathematics courses at the University of Limerick at the beginning of the university academic year '06/'07. The questionnaire was used to assess students' attitude towards mathematics (Aiken, 1974), self-concept of mathematics (Gourgey, 1982), beliefs about mathematics (Schoenfeld, 1989), conceptions of mathematics (Crawford et al., 1998) and general approaches to learning (Biggs et al., 2001). Through critical analysis of the data, relevant findings are highlighted and recommendations made for future research.

Introduction

It is becoming more and more important to realise the impact the affective domain has on learning. Its importance is highlighted by some theorists such as Atkin & Helms (1993) who suggest that affective components are as important as the content itself. McLeod (1992) and Reyes (1984) describe beliefs, attitudes and emotions as playing an important role in the learning of mathematics. Such affective factors in conjunction with numerous other variables have led to concerns in Ireland about a lack of mathematical preparedness among third-level entrants. The most recent Chief Examiner's Report at Leaving Certificate (2005: 72) made significant comments for both Higher and Ordinary Level mathematics. At Higher level Leaving Certificate "candidates conceptual understanding of the mathematics they have studied is inferior to that which one would hope for and expect at this level". At Ordinary level, the Chief Examiner commented that students possessed poor foundation skills, inadequate understanding of mathematical concepts and under-developed problem-solving and decision-making skills.

Worrying statistics were unveiled after the Leaving Certificate examination results were announced on Wednesday 15th August ’07. According to the Irish Times national paper, close to 5,000 students failed mathematics at either Ordinary, Higher or Foundation level, making them ineligible for third level courses. 12% of students failed Ordinary level maths which is the biggest single exam in the Leaving Certificate. The steep decline of numbers taking Higher level mathematics is worrying and will have a knock-on effect on third level education. A substantial small cohort of students will qualify this year for science, engineering and technology related area.

The authors anticipate difficulties arising in third-level mathematics given the strong evidence among the research that a ‘gap’ exists between secondary and university mathematics e.g. Kayander and Lovric (2005), Hoyles et el. (2001) and Anderson (1996). This paper focuses on issues arising during the transition from secondary school mathematics to university mathematics with particular attention to the role of affective factors on mathematics learning. Relevant research, methodologies, exploratory research and findings carried out by the author will be discussed.

Role of Affective Factors in Learning

McLeod (1992) divides affect into three dimensions:

- Attitudes
- Beliefs
- Emotions.

These affective domains along with self-concept, self-efficacy, and confidence play a major role in students’ mathematics learning.
According to Owens et al (1998: 109) “repeated emotional reactions to mathematical situations become habitual and an attitude towards mathematics develops”. Attitudes are often based on past experiences (Fishbein and Ajzen, 1975). Students’ experiences at second level education are correlated to their success in university mathematics courses (Kayander and Lovric, 2005). Therefore tackling the issue early and identifying where and how attitudes develop is essential.
The literature suggests that attitudes and beliefs are interlinked. Fishbein and Ajzen (1975:15) suggest that attitudes, beliefs and behaviour are linked to one another. They claim attitudes may influence the formation of new beliefs. Likewise, behaviour may result in new beliefs about the object, which may then influence the attitude. They provide a conceptual framework relating beliefs, attitudes, intentions, and behaviours with respect to a given object.

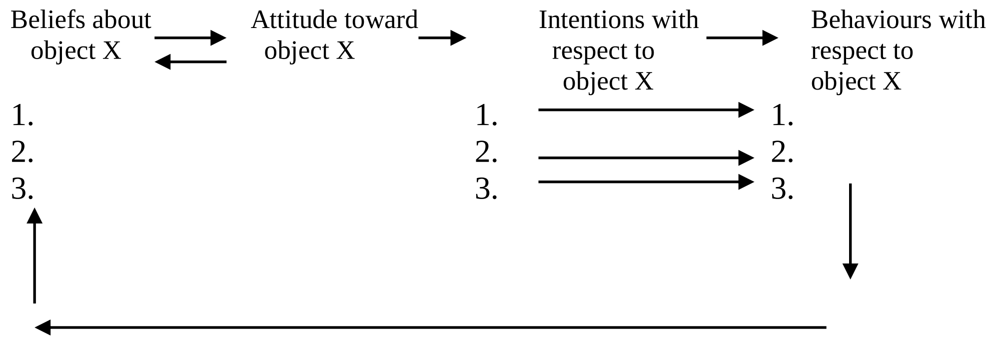

Figure 1 Schematic Presentation of Conceptual Framework Relating Beliefs, Attitudes, Intentions, and Behaviours with Respect to a Given Object.

McLeod (1992:579) says, "beliefs are central in the development of attitudinal and emotional responses to mathematics". Reyes (1984) is consistent with McLeod's view claiming that beliefs about individual competence in mathematics are closely tied to confidence and self-concept. Beliefs about mathematics shape students' behaviour and can often produce negative consequences (Mason and Scrivani, 2004).

Much of the literature also links beliefs and knowledge together. Studies by researchers e.g. Perry (1970) claim students' beliefs about knowledge influences their understanding of the subject matter and their ability to perform well. Dahl et al. (2005:271) completed a study examining the relationship between beliefs about learning and knowledge, and learning strategies used by Norweigan university students. An important finding emerged from Dahl et al.'s study "…the evidence is mounting in support of beliefs about knowledge and learning not only as achievement mediators, but also, perhaps, as mediators of decisions made during the learning process". Preventing and dealing with negative beliefs becomes an obvious task.

Laurie Buxton (1981:13) explains how "mathematics is commonly seen as a study based on reason, with the emotions rarely engaged". Larcombe (1985:6) found that strong emotions predominantly negative ones, are linked with mathematics, "evidence of negative feelings and attitudes to mathematics learning is so common a factor amongst the least able pupils in our secondary schools that we are in danger of assuming that it will inevitably be present". George Mandler's (1985) work also focuses on the role of emotions. Mandler explains that when a student is given a mathematical task, he/she produces an action sequence to complete the task. If the student experiences an interruption whereby he/she can't finish the task, the student normally experiences arousal in the nervous system e.g. muscular tension, increased heart rate. The individual also uses cognitive processes to evaluate the interruption that is interpreted as satisfaction, frustration or some other emotion.

Other areas of the affective domain such as self-concept, self-efficacy and confidence are reported to influence the students' learning of mathematics. Confidence influences learning and it stems from the students' beliefs. According to McLeod (1992: 583) "confidence correlates positively with achievement in mathematics".

Self-concept is another factor linked with achievement in mathematics. "Mathematical self-concept is defined as beliefs, feelings or attitudes regarding one's ability to understand or perform in situations involving mathematics" (Gourgey, 1982:3). A person's self-concept in mathematics is also formed by past experiences making early intervention invaluable. Similar to self-concept, self-efficacy also correlates to achievement in mathematics. Hackett and Betz (1989) found it correlated positively with achievement and attitudes towards mathematics.

Students' approaches to learning mathematics are shaped by these affective variables. The influence of these factors on the general transition to university and in the transition to university mathematics specifically will now be discussed.

Making the Transition From Secondary School to University – Academic and Social Adjustments

Research has shown e.g. Kantanis (2000), Jones and Frydenberg (1998) and Pargetter et al. (1999) that making the transition from secondary school to university is a difficult time for students, both academically and socially. According to D'Souza and Wood (2003:1) "tertiary students' experiences during their first year of study appear to be crucial to their personal adjustment and academic performance". They claim also that adjustment problems at the beginning of undergraduate study can result in student dropout or deferring of courses. Dalziel and Peat (1998) believe also that students' ability to adjust both academically and socially to university life will determine whether they continue their studies or not. Jones and Frydenberg (1998: 3) point out that during this transitional period "many students experience stress associated with academic concerns and encounter difficulties adjusting to an environment that presents new academic and social demands". Many authors identify various stressors that these first year students face. Pargetter et al. (1999) say a loss of confidence is an obvious consequence of a difficult transition. This in turn will influence student learning. The ease of the academic transition will also depend on how students adapt to different learning styles and become independent learners (Kantanis, 2000).

Jones and Frydenberg (1998) highlight both the academic and social difficulties associated with the transition. On the academic front, stress and anxiety interfere with their learning and progress. Once within the university issues such as teaching approach, curricula design, student motivation and approach to studying all influence student success. Reseachers such as Parker et al. (2004); Pargetter et al. (1999); Abouserie (1994), emphasise the social demands that arise such as loneliness, less time with family and friends, feeling unwelcome, failure to engage with other students, feelings of isolation and learning to cope as an independent adult. The extent of such stress depends on a number of variables e.g. full or part-time attendance, employment status, family obligations, distance from hometown, financial concerns and gender (Parker et al. 2004). A study by Kantanis (2000) reported the results of a study on the views of first-year university students commencing their studies. The most distinctive finding of the students' responses is their emphasis on social aspects of the transition to university. The study concluded that not having friends increased the difficulty of the transition to university and can have many consequences for students e.g. undermine self-confidence and self-esteem; inhibit the development of socialisation skills; restrict the speed of familiarisation with the university; reinforce feelings of negativity toward the institution, others and self to name but a few. This area of isolation in the transition from school to university is well researched by Peel (2000). Peel draws on the research of 200 students who completed Year 12 in various Australian schools in 1996 and commenced tertiary study in 1997. The most distinctive response from these questionnaires given to final-year secondary students in 1996 was the fears of isolation and university education being fragmented and individualistic.

Student's Approaches to Learning

As well as these stressors, students' approaches to learning are an important aspect to the transition to university. Anthony (2000) says students' conceptions of learning have an onward effect on the way they approach their studies and in turn affects the quality of their learning. Again findings from Dahl et al.'s study (2005: 269) indicate "the more students believe that learning ability is fixed, the fewer the strategies they report using to connect their prior knowledge with new knowledge that is to be learned, or to think critically about the information that they are processing".

The type of approach to learning that student's adopt is a strong deciding factor on whether students transition to university is successful or not. Cano (2005: 206) says approaches to learning reflect "learner's ideas or conceptions of learning, how they experience and define their learning situation, the strategies they use to learn and the motivation underlying their conduct". Marton and Saljo's (1976) work focussed on students approaches to learning and they identified two processes, deep-level and surface-level. In surface approach learning, the main focus is reproduction of knowledge. Biggs (1993:6) describes the 'surface approach' in the SAL framework as a "guiding principle or intention that is extrinsic to the real purpose of the task". Deep-level learning on the other hand aims for comprehension. Cano (2005:206) describes Marton and Saljo's (1976) work. He explains "students who pay attention to details in order to reproduce them later on, have a superficial idea, or quantitative conception, about learning". In contrast, students who understand the meaning of what they are learning have a deep idea and qualitative conception about learning. It is based on interest in the subject matter and the aim is to maximise learning. Ramsden (1992:45) believes "surface approaches are uniformly disastrous for learning". He found that those students who use deep approaches adapt better to higher education demands and are most committed to studying.

'Gap' Between Secondary School Mathematics and University Mathematics

There is no question that there is a distinctive gap between secondary and university mathematics. Ramsden (1992) has reported that studying and learning approaches at university level are influenced by learning and practices at secondary school. Anderson (1996) investigated instrumental and relational understanding among mathematics undergraduates. He believes students making the transition to undergraduate mathematics in the UK, have become heavily reliant on the instrumental approach. This according to Anderson (1996:813) hinders students' learning of mathematics.

Hoyles et al. (2001: 833) identified three main problem areas in the conceptual gap between school and university mathematics.

- Lack of mathematical thinking (i.e. the ability to think abstractly or logically and to do proofs),
- Weak calculational competence
- The students' lack of 'spirit' i.e. lack of motivation and perseverance.

Another factor that often widens the gap in the transition is one's conceptions of mathematics. Students' conception of mathematics influences their approach to learning. Research indicates that tackling the issue of conceptions of mathematics should begin with the teachers. On entering university, lecturers already have a conception of students' mathematical ability and knowledge. According to Thompson (1992) there is a strong relationship between teachers' conceptions of teaching and their conceptions of students' mathematical knowledge. These conceptions are not always beneficial to student learning. According to a number of researchers e.g. Thompson (1992) and Ball (1988), teachers' beliefs and conceptions about maths teaching and learning are formed by their own experience as students. Changing teachers' conceptions, thus changing students' conceptions and approaches to learning, is vital and must begin in school. Klinger (2004) conducted a study examining the attitudes, self-efficacy beliefs, and math-anxiety of a diverse group of pre-tertiary adult learners participating in an alternative entry program for admission to higher level. Students completed a mathematics foundation course. Tutors were instructed on how they were to carry out lessons. For example to help and encourage students to find new and positive ways to approach math-related material, stress that participation and genuine effort to understand material are more important than getting full marks and students were encouraged to take reasonable risks, feel free to make mistakes and with guidance and construct their own learning. He found significant improvement in the views and beliefs of students towards mathematics and their willingness to engage in mathematics learning and suggests that challenging their negative attitudes, their self-efficacy beliefs, and their anxiety can change students' perceptions of maths.

Exploratory Research

The aim of the exploratory research was to establish and examine the extent to which affective variables influence students' mathematics learning in the transition from secondary school mathematics to university mathematics.

Methodology

The research in the exploratory phase incorporates quantitative methodologies. The data consisted of the coded response of 608 questionnaires returned from first year students at the University of Limerick. Questionnaires were analysed statistically using SPSS software (Version 13). The data was analysed using firstly graphical representations such as frequency tables and bar charts for categorical data as well as cross tabulations, histograms and box plots for analysis of continuous data. Spearman's Rank correlation was used to check for correlations in Aiken's (1974) E and V Scales. Kolmogorov-Smirnov was used to test the data for normality.

Research Sample

The author needed to work with students making the transition from secondary school mathematics to university mathematics and who are studying service mathematics courses at the University of Limerick. Three groups were chosen: Engineering Mathematics 1, Science Mathematics 1 and Technological Maths 1. The author chose to focus on students from SET disciplines due to the increasing concern, mentioned earlier, within Ireland surrounding these areas of the economy.

The large sample size and various groups within in the sample allowed for much diversity in ability.

Research Design

Development of the Research Instrument

A questionnaire for third-level students was designed and implemented using Foddy's (1993) 'TAP' paradigm i.e. the topic should be properly defined so that each respondent clearly understands what is being talked about; questions should be applicable to each respondent and have a specified perspective. Keeping this in mind a draft questionnaire was developed that is fit for this purpose.

Drafting the questionnaire

Kulm (1980) regards the Likert scale as the most widely used self-report procedure as regards measurement of attitudes. They are widely used in education and according to Cohen et al. (2000) they offer the researcher freedom to use measurements with opinion, quantity and quality. Therefore the author felt it both appropriate and useful to adapt studies that used Likert scales to measure attitude, belief, self-concept, conceptions of mathematics and approaches to learning. The author's questionnaire consisted of 78 statements based on these attitudinal scales. They include Aiken's (1974) 'Two Scales of Attitude Towards Mathematics (Enjoyment and Value)', Schoenfeld's (1989) 'Beliefs about Mathematics', Gourgey's (1982) 'Mathematical Self-Concept', Crawford et al.'s (1998) 'Conceptions of Mathematics' and Biggs et al.'s (2001) 'Revised two-Factor Study Process Questionnaire'. They were adapted for use as considered necessary.

Piloting the Research Instrument

The questionnaire was piloted with six Leaving Certificate students and six mathematics teachers in May 2005. The purpose of this was to ensure wording and length were appropriate. The author spoke to each participant following their completion of the questionnaire, discussing the content, wording of questions and the length of the questionnaire. Subsequently any necessary changes were made to produce the final research instrument.

Final Research Instrument

The questionnaire comprises of the following five scales, Aiken's (1974) 'Two Scales of Attitude Towards Mathematics (Enjoyment and Value)', Schoenfeld's (1989) 'Beliefs about Mathematics', Gourgey's (1982) 'Mathematical Self-Concept', Crawford et al.'s (1998) 'Conceptions of Mathematics' and Biggs et al.'s (2001) 'Revised two-Factor Study Process Questionnaire'. The questionnaire was divided into 3 sections. The first section contained information about the student and their background. Section A and Section B were statements based on a five point Likert Scale. Strong feelings could be indicated on either side of the scale and there was an option for respondents who were unsure of statements (i.e. 1= strongly disagree, 2= disagree, 3=unsure, 4=agree, 5=strongly disagree).

Data Analysis

The data (both categorical and continuous) resulting from the questionnaire at third-level was analysed using the statistical package of SPSS (Version 13). Questions were coded for later analysis. All questions were given a unique code number and responses were entered into SPSS using these codes. Missing data were also coded so as to ensure that no question in particular was answered with a significantly lower frequency than other questions. Initial frequency checks were carried out on all variables to detect any coding errors in the data.

Discussion

The author wished to consider the extent of students' perceptions of maths during the transition phase from secondary school mathematics to university mathematics.

Response Rate

Each of these modules (Technological, Science and Engineering Mathematics 1) is made up of a number of different courses. That is, there are ten different courses within Engineering maths 1, nine within Science maths 1 and 13 within Technological mathematics 1. The response rate was analysed for each of the three service mathematics groups. It was found that Science mathematics 1 had the lowest response rate (54% of all Science mathematics 1 students completed the questionnaire). This was followed by Engineering mathematics 1 students (77% responded) and an 80% response rate from the largest sample size Technological mathematics 1. The author looked at the proportion of each course that attended the lecture and responded to the questionnaire within the three modules to see if any courses were under represented.

Technological Mathematics 1 - Most courses were represented well at the lecture. A greater percentage of each course attended the lecture and filled in the questionnaire than did not attend with the exception of Physical Education students. 61% of these students did not attend the lecture that day.

Science Mathematics 1 – The course within this module with the highest attendance rate was Science Degree with concurrent Teacher Education with 65%. The course with the least representation was Health and Safety (61% did not attend). In two more cases the percentage that didn't attend exceeded the percentage that did attend. 57% of Biomedical and Advanced Materials were not at the lecture and 52% of Food Science and Health students were absent.

Engineering Mathematics 1 – Within this module all courses had greater attendance than non-attendance. The course with the largest number of students, Mechanical Engineering, has 75% attendance.

Analysis of Questionnaire

The first area of concern is the *attitude* of students. Aiken's (1974) 'Two Scales of Attitude Toward Mathematics' was used to assess students' attitudes and as the name suggests comprises of two parts: enjoyment of mathematics (E scale) and value of mathematics (V scale). According to Aiken (1974: 70) "the E scale is more highly related to measures of mathematical ability and interest…" Out of 607 respondents, only 3 scored the total maximum 55 points (0.5%) in relation to enjoyment of mathematics. The minimum total E Scale score was 13 (0.2%). The mean score obtained was 37.6, which shows relatively high enjoyment levels of mathematics across the sample. Aiken (1974: 70) claims, "The V scale is more highly correlated with measures of verbal and general-scholastic ability." The V scale consists of 10 statements to E scale's 11. Therefore the highest possible total score is 50. The highest percentage of respondents scored 40 (9.3%) followed closely by 8.8% who scored a high 43. The minimum score by one respondent was 14. A mean score of 39.3 indicates students' appear to view mathematics as valuable.

Further analysis of the scales using Spearman's Rank correlation gave a clearer view of which statements correlated highly or not with enjoyment and value of mathematics. All correlations were statistically significant ($p < 0.01$) although not all items on both scales correlated very strongly with item scores. Strong correlations were found for most item scores and total scores on the E scale. The lowest correlation, $r = .623$, was between item 1 of the scale ("I enjoy going beyond the assigned work and trying to solve new problems in mathematics") and total E score. The highest correlation, $r = .845$, was between item 6 and total E score ("I have always enjoyed studying mathematics at school").

In relation to the V scale, the item-total correlations were not as high as those for the E scale. This is consistent with Aiken's findings. The lowest correlation, $r = .484$, was between item 1 ("Mathematics has contributed greatly to science and other fields of knowledge") and total V score. The highest correlation, $r = .650$, was between item 7 ("Mathematics is not important in everyday life") and total V score.

The next area of concern was the students' *beliefs* about mathematics using Schoenfeld's (1989) scale. A low score was assigned to negative responses and a high score to positive responses. Therefore the higher the mean score the better the beliefs about mathematics. The mean score was 20.7 out of a possible high score of 30. The scores ranged from 10 out of 30 (one subject) to 29 out of 30 (two subjects). The spread of scores may be attributed to the prior experience the students have had. This often determines how students behave e.g. the amount of time and effort students are willing to invest in a mathematics problem (Schoenfeld, 1989).

There was a relatively positive response to beliefs about mathematics although there was some evidence of reliance on procedural knowledge. Table 1 (below) indicates that almost all questions yielded positive responses, in particular item 35 ("Math problems can be done correctly in only one way."). The mean score for this item was 4.1 with 35.6% and 46.3% of respondents strongly disagreeing or disagreeing with the statement.

		Everything important about maths is already known by mathematicians	In maths you can be creative and discover things by yourself	Maths problems can be done correctly in one way	Real maths problems can be solved by commonsene instead of the maths rules you learn at school	To solve maths problems you have to be taught the right procedure, or you cannot do anything	The best way to do well in maths is to memorise all the formulas
N	Valid	607	606	606	605	607	607
	Missing	0	1	1	2	0	0
Mean		3.6326	3.3548	4.0924	3.3521	2.8830	3.3624
Median		4.0000	4.0000	4.0000	3.0000	3.0000	4.0000
Std. Deviation		1.14687	1.04819	.90071	1.02130	1.20416	1.08718

Table 1 Means, Medians and Standard Deviations on Beliefs about Mathematics

The statement **"**To solve maths problems you have to be taught the right procedure, or you cannot do anything" showed the lowest mean (2.9). This response would seem to indicate that students consider procedural knowledge of utmost importance, a situation described as problematic by researchers such as Biggs (1993), Dweck (1986) and Marton and Saljo (1976).

Mathematical self-concept is another area examined in the research instrument. Items in the questionnaire, based on Gourgey's scale, were worded both positively and negatively i.e. scoring on negatively worded items was reversed so that a high score would indicate a favourable mathematical self-concept. Possible scores range from a low of 12 and a high of 60. The mean of the mathematical self-concept scale for the sample of 600 students (7 missing) was 40.6, which is a positive finding and perhaps slightly higher than anticipated.

Crawford et al.'s (1998) '*Conceptions of mathematics'* scale was incorporated into the questionnaire to determine if students are either fragmented or cohesive learners. It was found that the mean for the Cohesive Conception scale (3.5) was substantially higher than the mean for the Fragmented Conception scale (2.7). This was a positive finding as it indicates that the students tended to lean towards cohesive learners although not completely rejecting fragmented statements. A low mean score however for the statement, "the subject of mathematics deals with numbers, figures and formulae" suggests a reliance on rules and procedures indicating an existence of rote learning.

Findings from Biggs et al.'s (2001) two-factor Study Process Questionnaire addressing deep and surface approaches to learning correlated with the findings from Crawford et al.'s (1994) scale i.e. deep approaches to learning correlates with cohesive learning and surface approaches to learning correlates with fragmented learning.

The questionnaire also includes subscales where students motive and strategy to learning can be calculated by adding the relevant item scales. Table 2 below describes Biggs et al.'s (2001) R-SPQ-2F dimensions, motives and strategies.

	Surface	*Deep*
Motive	Fear of failure	Intrinsic interest
Strategy	Narrow target, rote learn	Maximise meaning

Table 2 Revised Study Process Questionnaire: Dimensions, motives and strategies

Surface learners are usually motivated by a fear of failure and employ rote learning strategies. Deep learners tend to be intrinsically motivated to learn and wish to maximise their meaning and understanding of a subject. Scores ranged from 1 (“never or rarely true of me”) to 5 (“always or almost always true of me”).

The highest possible score on both scales was 50. The higher the score on the deep learning scale the better as this indicates a positive response to the deep approach statements and suggests that students favour comprehension rather than reproduction of knowledge. This can be linked to earlier findings where students seemed to lean towards cohesive learning. High surface scale scores however would show students were surface learners and aimed for reproduction of knowledge rather than aiming to understand the information. Scores ranged from 10 to 49 on the deep approach to learning scale, and from 10 to 42 on the surface approach to learning scale. The mean for the deep scale was 29.8 in comparison to the surface scale mean of 24.3. When the author examined the subscales however there is evidence of rote-learning and procedural knowledge. For example, students’ scored a mean of 13.4 out of possible 25 on the strategy for surface approach learning scale indicating that rote learning is a prominent strategy employed by surface learners in this sample.

Conclusion

Little research has been done on the influence of affective variables on the learning and teaching of mathematics. Based on the study carried out thus far by the author and by researchers in other countries, it is clear that attitudes, beliefs, emotions, mathematical self-concept, conceptions of mathematics and approaches to learning mathematics are crucial areas in the learning of mathematics and needs attention in an Irish context. While the findings have not been all negative, both literature and particularly studies by Gill (2006) have shown the struggle students in Service Mathematics courses endure.

It is recognised that affective factors impact on the mathematical preparedness of both Higher and Ordinary level mathematical students as they make the transition from secondary school mathematics to higher education. The author plans to investigate the issue of affective factors and the transition to university further by comparing final marks achieved by students in all three groups (Technology, Science and Engineering) with affective variables assessed by the research instrument discussed above. Qualitative data has also been collected in the form of interviews and will be used to shed more light on the issues at hand.

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