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Mathematical Anxiety as an Inhibitor of Skills Development in Accounting Students

The development of the technical and soft skills required of students as they move into the world of work has been much debated in the literature. This has been particularly true of accounting education where the development of quantitative skills is a key requirement of undergraduate curricula. There are, however, recognised problems with the development of mathematical skills one of which is the existence of mathematical anxiety among students, a condition which often inhibits engagement with mathematical activities and so hinders skills development. This paper reports on an initial quantitative study which identifies the presence of mathematical anxiety among a class of undergraduate accounting students, and identifies 'assessment in mathematics' and 'active mathematical engagement' as linked to anxiety production. The paper proposes teaching mathematical skills in conjunction with other soft skills as a mechanism for supporting and developing students as independent and confident learners which can help to reduce mathematical anxiety and its consequences.

Introduction

There has been some debate in recent years as to the extent to which accounting educational processes are producing graduates with the skills that employers require (Kavanagh & Drennen, 2008; De Villiers, 2010; Hissam & Hassim, 2014; Kent St. Pierre & Rebele, 2014). In the context of this study, management accounting educational processes refer to the courses of study offered by United Kingdom (UK) Higher Education (HE) institutions that specifically aim to produce graduates who are ready to enter the role of management accountant within the UK. Conventionally, these would be courses at Higher National Diploma, Foundation Degree, or Honours Degree level with the first two providing education at levels 4 and 5 within the UK HE qualifications framework and the third extending this to level 6. (QAA, 2014).

This debate has focussed on two areas: the first is the extent to which undergraduate course curricular are teaching the necessary techniques of value to the accountant; the second is the extent to which such courses are developing the appropriate skills to enable graduates to operate within their role effectively (Gammie et al., 2002; Weaver & Kulesza, 2014).

This paper focuses specifically on skills development and will consider one particular group of skills which are those related to mathematics. The preparedness of students entering HE to undertake courses of study that require significant quantitative skills has long been a matter of debate in the UK. While it is generally believed that changes to mathematics teaching and learning brought about by the Smith Report (2004) (through, for example, the creation of the National Centre for Excellence in the Teaching of Mathematics) have helped to alleviate the problem somewhat, it still remains a matter of concern to many HE institutions offering courses requiring the development of mathematical skills.

Many institutions undertake diagnostic testing of their undergraduate students on entry in order to try and identify the weaker students and, therefore, those that will require additional support. While this may identify gaps in a student's mathematical knowledge, it does nothing to address some of the underlying causes of poor engagement with, and hence performance in, mathematics. One cause that is known to be quite widespread among students of all ages is mathematical anxiety, and while it is recognised as an inhibitor of mathematical skills development it is rarely addressed within learning and teaching strategies at HE institutions.

This paper reports on the results of a quantitative study undertaken with a group of students beginning their training in accounting at a UK university. The courses on which theses students were enrolled focus on the development of both the technical skills required of an accountant and also the 'soft' skills that enable the practice of accountancy within an organisation. Furthermore it is argued that the technical and soft skills should not be separated for teaching purposes but should go hand-in-hand in contributing to the development of the student as a self-regulated learner. However, as an inhibitor of mathematical skills development mathematical anxiety can stifle the progress of the student towards learning objectives and so needs to be addressed. The study therefor aimed to answer three research questions:

1. What is the extent of mathematical anxiety exhibited by the students at the start of their undergraduate course and is this anxiety indicative of a need for support?
2. What are the underlying causes of such anxiety and do these point to ways in which it can be reduced?
3. How can the pedagogy of teaching quantitative skills be reshaped to help overcome mathematical anxiety?

Literature Review

The development of soft and hard accounting skills

There has been a traditional divide in the skills requirements for the accounting profession between the technical (hard) skills required to undertake the more analytical side of the role, and the personal (soft) skills that underpin effective performance within the organisation. How educators should address both types of skill has been a matter of some debate for a number of years in accounting education. First considering the development of soft skills, four studies are worthy of note: those conducted by Gammie et al (2002), by Pang and Hung (2012), by Weaver and Kulesza (2014) and by Kent St. Pierre and Rebele (2014).

Gammie et al (2002) identified the skills that employers considered their graduate employees should have and developed a module in skills development taking into consideration the views of four stakeholder groups including employers, post placement students, and the British Association of Business Studies Industrial Placements (BABSIP). The course team then identified 13 skills that needed to be embedded within the undergraduate programme via a 'Business Enterprise Skills' module to be delivered on the second year as one of eight taught modules. These skills included time management, written and oral communication, practical research skills and team working skills. Their conclusions included that in skills development staff selection is very important, as are delivery methods, and assessment processes. They also suggested that module evaluation should be by students and employers, and that there is a need for further research into skills development methods and pedagogy.

In relation to personal skills development (PSD) the study by Pang and Hung (2012) identified that '… PSD programs have important issues that need to be addressed more comprehensively than at present in the education literature if the pedagogical support of the current focus on PSD is to be fully realized' (159-160). They also contended that '… higher education does not seem to be producing graduates with the required skills and abilities at the level organisations expect' (160). They concluded that for effective skills delivery there is a key requirement to use experiential learning approaches perhaps based around a framework such as the Kolb learning cycle (Kolb, 1984).

Weaver and Kulesza (2014) summarised the results of various studies identifying the opinions of employers of accountants in the USA and these are reproduced in Table 1. These findings are interesting in their diversity and also in that they bridge what might be termed conventional soft skills (time management, communication etc.) and also skills overlapping with the technical side of accounting (problem solving, analytical reasoning etc.). Weaver and Kulesza identify critical thinking, problem-solving and communications skills as their focus and describe how these can be embedded into the accounting curriculum.

Finally, Kent St. Pierre and Rebele (2014) drew a number of conclusions for skills development on undergraduate courses including that the accounting profession is unclear about the skills that they desire, that there is a lack of clarity about what many of the terms relating to skills actually mean, and that it is an open question as to whether skills can indeed be taught at all.

This brief review of the soft skills literature has surfaced a range of conflicting views and ideas and while there seems to be fairly universal agreement as to the value of soft skills to the graduate accountant, the nature of these skills, where they should be developed and by whom seems to be very much an unresolved question.

Turning now to the development of technical skills, there is fortunately less doubt that there is a need for students to develop competencies in mathematics as the day-to-day work of the accountant requires a familiarity with numbers and an ability to manipulate them. Francis, Spencer and Fry (1998) contend that while accountants may not need advanced quantitative skills on a day-to-day basis (since many tasks are conducted using IT) there is a need for them to be able to interpret and question results and to know which techniques to use in a given situation. Their study of nearly 300 employers and a smaller number of academics found some consistency in the expressed need for graduates to be able to understand fractions and percentages, powers and roots, linear equations, probability and statistical methods together with some more advanced topics such as linear programming and calculus although these last two were far less common as requirements. Marchant (2013) explores the role of the management accountant in the 21st Century and contends that successful organisations have the capacity to develop an analytical capability and that this should be reflected in the role of the accountant. He considers a skill set that includes experience in data analysis, an understanding of the core issues of data management related to data relevance, data sourcing and data quality, and an ability to understand the business and relate analytics to the business. On the educational side, a further study by Al-Twaijry (2010) found that a student's performance on pre-university mathematics courses had a significant effect on the student's later performance on a managerial accounting course taken at university level implying that there is a need to assess these mathematical skills on entry to the course if students in need of support are to be identified early.

Table 1.
Top five soft skills from the employer's perspective (Weaver & Kulesza, 2014)

Study	**Top Five Soft Skills**				
Weaver & Kulesza (2013)	Problem Solving	Critical / Strategic Thinking	Time Management & Organization	Memos & Writing Skills	Intermediate /Advanced Skills
Hart Research Associates (2013)	Critical Thinking	Problem Solving	Written / Oral Communication	Applied Knowledge in Real World Applications	Ethics and Integrity
Holtzman & Kraft (2011)	Interpersonal Skills	Time Management	Speaking / Oral Communication	Ethical Understanding	Adapting to Change / Being Flexible
AICPA Vision 2011 (1999)	Communication Skills	Leadership Skills	Strategic & Critical Thinking	Focus on the Customer, Client and Market	Interpretation of Converging Information
LEAP (2007)	Teamwork Skills in Diverse Groups	Critical Thinking and Analytic Reasoning	Written and Oral Communication	Information Literacy	Creativity and Innovation
Blanthorne et al.(2005)	Technical	Communication	Interpersonal	Administrative	Leadership

While there is often the distinction made between hard and soft skills by educators, it seems clear that employers do not necessarily make this distinction so clearly. Furthermore it can be argued that for students there are aspects of both skill sets that go hand-in-hand so that developing certain soft skills can assist in overcoming some issues in the development of the hard skills. This paper argues that such a case is the study of mathematics as a supporting subject for accountants and in the existence of mathematical anxiety.

Mathematical Anxiety

Negative attitudes among students towards the study of mathematics have been evident for some years in both the adult population (Sewel,

1981) and among secondary school pupils (Larcombe, 1985). The situation among university level students is barely different (Yenilmez, Girginer & Uzun, 2007) and research has been reported on ways of supporting students on university courses who struggle with mathematics and who have negative attitudes towards the subject (Patel & Little, 2006; Carroll & Gill, 2012).

Negative attitudes can, of course, take many forms from a simple dislike of mathematics to a dread and fear of undertaking any mathematical task and in this latter case the fear (or anxiety) can be so severe as to have an impact on assessment performance or even influence students' choices of degree or career (Chipman, Krantz, D. & Silver; 1992). The impact of anxiety on performance is particularly problematic in subject areas where mathematical skills are important but are a supporting subject and therefore not the main focus of the student's study. A study of drug calculations among nursing students for example found that numerical ability closely followed by the extent of mathematical anxiety were the main personal factors influencing nursing students' drug calculation ability (McMullan, Jones & Lea, 2012).

Mathematical anxiety has been the subject of research within UK HE institutions and elsewhere (Metje, Frank & Croft, 2007; Warwick, 2011). Interestingly there is mixed evidence as to the effect of gender and age on mathematical anxiety with some studies reporting gender and age differences and others reporting none. A study by Devine et al. (2012) provides an excellent summary of this conflicting evidence citing a variety of studies that have shown anxiety differences due to gender and contrasting these with studies showing no such effect. They also consider the notion of test anxiety and how this can confound the measurement of mathematical anxiety.

In terms of students studying accounting courses very little work has been done in assessing the anxiety levels of students. There has been limited research, for example by Malgwi (2004) or Duman et al (2015), which has looked at accounting anxiety among students but there has been very little research conducted regarding the mathematical anxiety levels of accounting students.

Assessing the level of anxiety felt by students for a particular subject area is usually undertaken using context specific questionnaires. For example there is a Computer Anxiety Rating Scale (Broome & Havelka, 2002), an Accounting Anxiety Rating Scale (Malgwi, 2004), and for assessing levels of mathematical anxiety the Mathematics Anxiety Rating Scale (MARS) (Richardson & Suinn, 1972). The MARS questionnaire consisted of 96 questions designed to assess anxiety related to two areas: learning mathematics and mathematics evaluation. Further work by Plake and Parker (1982) produced a simpler Revised Mathematics Anxiety Rating Scale (RMARS). This consisted of a reduced set of 24 statements each describing a mathematical activity and respondents are asked to rate themselves on a Likert scale ranging from 'not at all anxious' to 'extremely anxious' for each of the 24 situations described.

The treatment of mathematical anxiety has also been discussed in the literature although not perhaps as extensively as one might have thought given the volume of literature relating to its identification and measurement (Taylor & Brooks, 1986; Furner & Berman, 2004; Kramarski, Weisse & Kololshi-Minsker, 2010). It is recognised that the causes of mathematical anxiety can often be traced back to experiences early in a student's education – perhaps resulting from poor teaching, poor assessment results, or just a lack of appreciation as to the importance of mathematics in everyday life - and so some interventions have been targeted at school level mathematics teaching (Kramarski, Weisse & Kololshi-Minsker, 2010). However, the consequence of students arriving at university with high levels of mathematical anxiety are that they are tempted to avoid mathematics as far as possible with consequent effects on mathematics assessment (McMullan, Jones & Lea, 2012). Thus the student becomes trapped in a vicious circle with avoidance of mathematical work producing poor mathematical assessment outcomes leading to further disengagement from mathematical study (Warwick, 2009). Some work has been undertaken to look at these issues at the university education level (Everingham, Gyurisb, & Sextona, 2013; Warwick & Howard, 2014) but little has been reported on mathematical anxiety in the area of accounting education.

Self-regulated learning

Kramarski, Weisse & Kololshi-Minsker (2010) describe two types of mathematically anxious students. The first is the group of students who lack the study skills to achieve any successful educational outcomes and consequently experience failure including in mathematical subjects. The second is the group of students who have adequate study skills but are inhibited by mathematical anxiety from applying them successfully and therefore experience difficulties with mathematical subjects. This paper argues that students in both groups can be helped by the close alignment of mathematics skills development with soft skills development so that progress in each can support the other directly. Further, the notion of students becoming independent, confident, self-regulated learners is one approach to reducing anxiety related to any learning – and not just learning in mathematics.

Self-regulated learning is considered to be a key component in the acquisition of knowledge in HE and of lifelong learning in general particularly in an age when the requirements of job roles (and the accounting profession is no exception) are evolving rapidly (Cassidy, 2011). Self-regulated learning is conceptualised as '… the way in which learners control their thoughts, feelings and actions in order to achieve academically …' (989). It has been suggested that self-regulated learning has at its heart three constructs: student self-evaluation; an understanding of preferred learning styles; and academic control beliefs i.e. the extent to which students can exert control over their academic studies and balance conflicting pressures. These constructs are central to the cyclic process of forethought – performance – self-reflection which make up the three phases of self-regulated learning (Zimmerman, 2002). Students new to HE rarely have the underpinning skill set to move through these phases effectively and so must be supported through the development of the required skills preferably in the first year of their studies.

Drawing together some of the threads in this literature review, it seems clear that there is advantage to be gained by interconnecting the teaching of quantitative skills with soft skills. On the one hand, Table 1 identifies problem solving and analytical skills as part of the essential accountant skills core (Weaver & Kulesza, 2014) and mathematical reasoning together with quantitative skills would be a key component of this. On the other hand developing quantitative skills among maths anxious students requires their development as self-regulated and independent learners – and the development of soft skills plays a key part here. Thus there is an argument to include quantitative skills development as both supporting, and supported by, soft skills development and to separate them by teaching quantitative skills in a separate module does not help this integration.

This paper now describes a survey of undergraduate students who enrolled onto a Foundation Degree (FdA) in Accounting in September 2014. The survey measures levels of mathematical anxiety and compares this with performance on a mathematical diagnostic test which all new students on the course are required to take. Further analysis describes some of the underlying causes of the anxiety and finally the paper suggests pedagogic approaches that can be a means of relieving some of these anxiety causing factors.

Methodology

The Accounting and Finance department in the School of Business delivers one of the most successful suites of undergraduate courses developed at London South Bank University (LSBU). In 2013/14 there were 717 students studying on an undergraduate Accounting and Finance course, with a total of 159 on the FdA Accounting and BA (Hons) Accounting programme combined. The FdA Accounting is a two year course which offers modules at levels 4 and 5 of the UK Higher Education Framework. In the context of these courses a module is typically a single semester teaching programme comprising 4 hours per week of class contact time which would contribute 20 credits to the total of 120 credits studied in an academic year. The FdA Accounting course philosophy is to integrate the theoretical and conceptual rigour of an academic education with part-preparation for professional practice. The course rationale is to offer a mix of theoretical accounting, financial and general business modules along with work related learning that together extend the students understanding of the financial world. Thus, the course equips students with the knowledge and skills to appeal to employers within the accounting sector with a particular emphasis on graduate opportunities within small to medium-sized enterprises (SMEs). This focus on SMEs supports the course philosophy that students should be work-ready when they graduate from the course (even though many students progress to further study at level 6 in order to complete a full undergraduate degree qualification) and this requires the course to focus on both hard and soft skills development.

In September 2014 a cohort of 60 students began the first year of the FdA Accounting and a request for voluntary participation in this research yielded a sample of 40 students who were asked to complete a questionnaire designed to assess their degree of mathematical anxiety. In this study, a slightly modified version of the RMARS questionnaire was used in which the modifications were made to tailor the statements to the UK education environment and to update some of the terminology (for example the use of 'whiteboard' rather than 'blackboard', 'calculator' rather than 'tables in the back of the book'). The questionnaire consisted of a set of 24 statements and for each of these the students were asked to indicate how anxious they would feel on a 5-point Likert scale ranging from 'Not at all anxious' (denoted by 1) to 'Very anxious' (denoted by 5). Statements encompassed situations involving assessment (thinking about a mathematics test the day before), classroom learning (watching a teacher solve an equation using algebra on the whiteboard) and learning support (buying or borrowing a mathematics text book).

The students were then asked to complete a diagnostic mathematics test which was designed to assess their basic knowledge of arithmetic, algebra and linear equations. Although all students are required to have a UK General Certificate of Secondary Education (GCSE) in Mathematics (or an equivalent qualification) experience has shown that the mathematical ability of the incoming students is very varied and weaker students need to be identified for additional support. For students on the FdA Accounting course mathematics is developed in the first year of the course (level 4) through a Professional Skills module which places side-by-side the development of mathematical skills and associated soft skills. During the course of the module students were assessed in mathematics by means of a formal exam and by coursework for the remaining skills elements of the module. Irrespective of the coursework mark achieved, students are required to pass the mathematics exam at 40% or better if the entire module was to be considered as a pass so the development of mathematical skills is considered highly important.

Empirical data from the items making up the RMARS questionnaire were investigated to identify any underlying commonalities and structures using Exploratory Factor Analysis (EFA) - a well-known statistical method for exploring empirical data when there is no existing hypothesised relationship between items or variables. This study used this method to determine whether there are underlying factors that can group into sub-sets the 24 items on the RMARS questionnaire to indicate potential causes of anxiety among these students. All data was analysed using the Statistical Package for the Social Sciences.

In order to conduct the EFA analysis a five-step process was used (Williams, Brown & Onsman, 2010). For a discussion in relation to the use of factor analysis using SPSS see Pallant (2010). Key decision in the EFA process are to first test whether the data is suitable for EFA using the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests, and then to decide on the number of underlying factors to be derived.

The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test are important statistical measures of data suitability. The KMO test is a measure related to correlation among the variables that is reported as a continuous variable between 0 and 1. A value close to 0 indicates that the data is widely diffused and unsuitable for factor analysis as there are not likely to be clusters of correlated measured variables in the data. On the other hand a value close to 1 indicates that the patterns of correlations are such that factors are likely to emerge. Kaiser (1974) recommends that values greater than 0.5 should be acceptable to proceed with the factor analysis. Bartlett's test is related to the correlation matrix and tests the null hypothesis that the correlation matrix is an identity matrix. In other words it tests a null hypothesis that there is no significant correlation between individual pairs of measured variables.

How many factors should be extracted from among the 24 survey items is a matter of judgement to a certain extent. In our case the limits are of a single factor containing all the RMARS items, or of 24 factors each containing one item. Help in deciding on the number of factors can be provided by a scree plot as shown in Figure 1.

In Figure 1 the vertical axis (Eigenvalue) is a measure of the variation in the data explained by the extraction of each additional factor (or component as they are also sometimes labelled). Various methods have been suggested for deciding on the number of factors to extract and a good summary is contained within Ledesma and Valero-Mora (2007). Two popular criteria are Kaiser's eigenvalue-greater-than-one rule and Cattell's Scree test. In the former case the factors are selected which have an eigenvalue greater than 1 which in this case would be five. Additional factors (with eigenvalue below 1) do not add much to explanation of the variation observed in the data. In the latter case Figure 1 can be examined to ascertain when the graph 'levels off' indicating that there is not significant explanatory power added by the extraction of more factors.

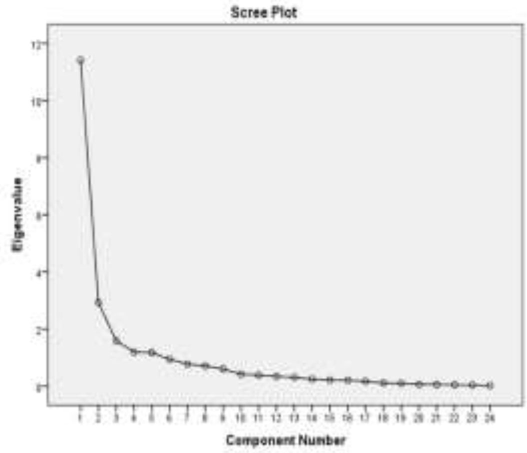

Figure 1: Scree plot

Once the factors have been extracted the researcher examines the measured variables that make up each factor so that the meaning of the latent variable can be ascertained. This is not by any means easy and the researcher should keep in mind that the resulting latent variables should have an interpretation that fits within the theoretical framework of the research and there can be benefit in trying to relate the factors to theoretical constructs perhaps posed in the relevant literature.

Study Results

From the RMARS questionnaires, the total anxiety score for each student was calculated by summing the response scores across the 24 statements. The total anxiety score was a figure between 24 (indicating that the respondent ticked the lowest anxiety response for each of the 24 questions) to a maximum of 120. The sample of students was broken down by age (coded into three groupings) and gender. The breakdown is shown in Table 2.

Table 2.

Student sample by gender and coded age

	Female	Male	Total
Coded Age			
17 or 18	4	13	17
19 - 25	8	7	15
Over 25	5	3	8
Total	17	23	40

The analysis first compared the distribution of total anxiety score for males and females using the non-parametric Mann-Whitney U test and this demonstrated no significant difference between the distributions for males and females ($p = 0.85$, two-tailed test). The distribution of total anxiety between the three age groups was then compared using the non-parametric Kruskal-Wallace 1-way ANOVA and this also returned a non-significant result ($p = 0.066$, two-tailed test). The box-plot showing the distribution across age groups is given in Figure 2. The boxes show the range of values between quartiles 2 and 3 of the data (i.e. the middle 50% of data values) while the horizontal line in each box shows the median value. Whilst younger students do seem to have more consistently higher anxiety scores than other age groups the result is not statistically significant.

Since there were no significant differences in total anxiety at the 5% level when the sample was broken down by age or gender, all further analysis was conducted using the whole sample without further analysis by gender or age.

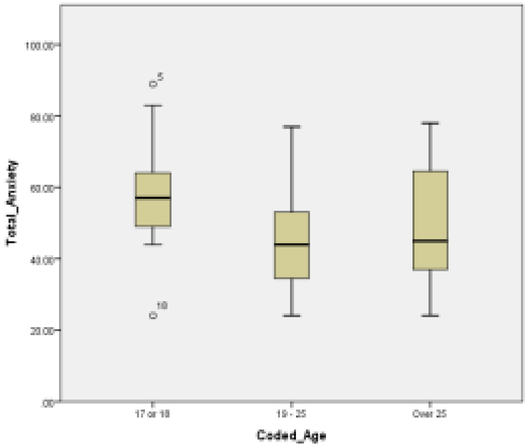

Figure 2: Boxplot of total anxiety by age category

Figure 3 shows the scatterplot of the total anxiety score for each student against their diagnostic test score.

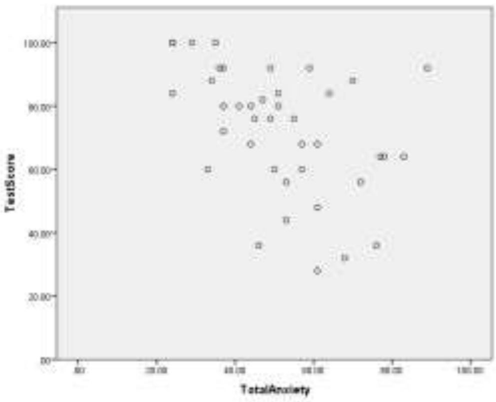

Figure 3: Scatter plot of total anxiety score against diagnostic test score

Calculating Pearson's correlation coefficient for this data returns a value of -0.452 which indicates a significant negative correlation ($p = 0.003$, two-tailed test). This would indicate that the greater the level of total anxiety indicated by the student, then the lower the diagnostic test score achieved. This result confirms other results reported in the literature that levels of mathematical anxiety can impact adversely on performance in mathematical assessments.

In order to try and uncover the main causes of mathematical anxiety for these students, an EFA was conducted among the 24 statements of the RMARS to see whether those items on the survey that were highly correlated were indicative of some underlying factor that could be identified. To test the suitability of the data for this type of analysis the Kaiser-Mayer-Olkin (KMO) test and Bartlett's test were applied with results as shown in Table 3.

Table 3.

KMO and Bartlett's test results

KMO Test.		.746
	Approx. Chi-Square	847.4
Bartlett's Test	df	276
	Sig.	.000

As previously mentioned, the KMO test returns a figure between 0 and 1 and the observed result of 0.746 is good indicating that there is indeed likely to be value in extracting factors from among the 24 items. Bartlett's test is a measure of the degree of correlation between pairs of items and the reported result is significant ($p = 0.000$). These results allowed continuation of the analysis with the EFA.

Figure 1 shows the resulting scree plot for this analysis and taking into account both Kaiser's eigenvalue-greater-than-one rule and Cattell's scree test analysis proceeded with the extraction of four factors leading to the results as shown in Table 4.

The main survey items that make up each factor were taken as those which have factor loadings in excess of 0.55 and the items are ordered within each factor in decreasing order of factor loading. Examination of the survey items that make up each factor allowed identification of the general theme of each factor as shown in the final column of Table 4 and then further linked this with the theoretical learning styles of Kolb (1984).

Regression methods can be used to find a standardised factor score for each respondent. These scores are standardised in the sense that over all respondents the mean factor score is 0 and the standard deviation is 1. Correlating these scores against the respondent's diagnostic test scores produces the results shown in Table 5.

Discussion

The results presented above lead us to a number of conclusions and suggestions regarding the teaching of mathematical skills to our undergraduate accounting students and each of the research questions is considered in turn.

Question 1: What is the extent of mathematical anxiety exhibited by the students at the start of their undergraduate course and is this anxiety indicative of a need for support?

The study confirmed that mathematical anxiety is present in our level 4 accounting students and that it is unaffected by age or gender although there seems to be a slightly higher propensity for anxiety among younger students. Over the entire sample the median total anxiety score is 50.1 which equates to an average score of 2.1 per question. In other words the average student has a level of anxiety for each questionnaire item that is approaching the level of 'fairly anxious'. The FdA in Accounting course is typical of many within the university in that its entry cohort is very diverse (across the university some 38% of students are aged 30 or over and 52% come from ethnic minority groupings) and it seems that the issue of mathematical anxiety is one that permeates the entire cohort.

Mathematical anxiety was significantly correlated with the diagnostic test results. This has two implications: first, for the students weaker in mathematics, the high anxiety scores are indicative of a potential barrier to further mathematical skills development and so needs to be addressed; second, measuring mathematical anxiety could potentially be used as an alternative to diagnostic testing as a means of identifying those students in need of support. Diagnostic testing is not an ideal way to introduce students to university life as for the weaker students performing poorly on such a test can be a very negative experience. Completing an RMARS questionnaire on the other hand does not point so directly at specific areas of weakness and yet yields valuable information.

Question 2: What are the underlying causes of such anxiety and do these point to ways in which it can be reduced?

The exploratory factor analysis identified a four factor structure underpinning the 24

RMARS items. Interestingly two of these factors were significantly correlated with the diagnostic test results with negative correlation indicating that greater anxiety is associated with poorer test results. These were the components labelled as ‘assessment in mathematics’ and ‘active mathematical engagement’

Table 4.

Extracted factors and constituent survey items

	RMARS Items	Loading	Interpreted Factor
1	Walking into a mathematics class	0.855	Preparation and passive mathematical engagement Relating to the ‘feeling’ and ‘watching’ poles of the Kolb learning cycle.
	Walking into the university and thinking about the mathematics module	0.854	
	Getting a course timetable and seeing a mathematics module on it	0.836	
	Starting a new topic in the mathematics module	0.791	
	Listening to a mathematics lecture	0.751	
	Picking up a mathematics book to begin working on a coursework	0.744	
	Listening to another student explain a mathematical formula	0.720	
	Reading or interpreting graphs or charts	0.705	
	Looking through the pages of a mathematics book	0.674	
2	Being asked a mathematical question in class	0.854	Assessment in mathematics Relating to the ‘thinking’ and ‘doing’ poles of the Kolb learning cycle.
	Being given a surprise test in a mathematics class	0.818	
	Taking a mathematics assessment test in the module	0.790	
	Waiting to get a mathematics test result in which you expected to do well	0.778	
	Getting ready to revise for a test in mathematics	0.763	
	Working on an abstract mathematical problem	0.750	
	Seeing a mathematical formula in an accounting class	0.588	
3	Solving an algebraic equation yourself in class	0.818	Active mathematical engagement ‘thinking’, ‘doing’ and ‘watching’ poles of the Kolb learning cycle
	Thinking about a mathematics test the day before	0.676	
	Watching a teacher solve an equation using algebra on the whiteboard	0.635	
4	Buying or borrowing a mathematics text book	0.566	Borrowing a book All aspects of the Kolb Cycle

Table 5.

Factor scores correlated with test scores

	Factor 1	Factor 2	Factor 3	Factor 4
r =	-0.047	-0.398	-0.542	0.176
p =	0.775	0.011	0.000	0.278

It seems clear from this that it is predominately the act of engaging with mathematics and mathematical assessment processes that generates anxiety responses that reflect actual performance in the diagnostic test. These two factors are both associated with the ‘doing’ and ‘thinking’ poles of Kolb’s learning styles and so it would seem sensible to focus on these aspects of learning and teaching to see how teachers can work with students as they engage with the abstract conceptualisation and active experimentation phases of the cycle. This is where the development of soft skills plays an important role. The poles mentioned above are at the extremes of the two dimensions of Kolb's cycle. These dimensions relate to 'how we think about things' (Feeling or Thinking) and 'how we do things' (Watching or Doing). How students think about and undertake practical mathematical tasks can be better structured by the student through the appropriate application of soft skills and study skills. The intention here is to support those constructs of self-regulated learning related to learning styles and student self-evaluation.

Anxiety generated in other situations grouped in Table 4 as 'preparation and passive mathematical engagement' and 'borrowing a book' are not such good indicators of diagnostic test performance.

If mathematical anxiety is an inhibiter of mathematical skills development as previously discussed then removing some of this anxiety should induce greater student engagement with mathematics and this should then be reflected in mathematical assessment outcomes. This research suggests that of the three constructs underpinning self-regulated learning (student self-evaluation; an understanding of preferred learning styles; and academic control beliefs) heightened mathematical anxiety would impact negatively on student self-evaluation in mathematics and also academic control beliefs. As well as hindering mathematical skills development, mathematical anxiety acts to stifle the development of the self-regulated learner.

Question 3: How can the pedagogy of teaching quantitative skills be reshaped to help overcome mathematical anxiety?

As mentioned previously, students on the FdA Accounting course are taught mathematics during the first year of the course (level 4) through a Professional Skills module which places side-by-side the development of mathematical skills and associated soft skills. This is quite a novel approach to mathematics teaching as mathematics teaching is more commonly situated in a dedicated quantitative studies module or in accounting techniques modules. There are two main advantages to the more blended approach: firstly, it identifies mathematics as simply another supporting skill that accountants need to develop along with a host of others; secondly, it allows other soft skills to develop and emerge in close proximity which can have a natural role in supporting the development of mathematical skills, study skills and of producing self-regulated learners. In keeping with the underpinning concepts of self-regulated learning the curriculum for this module consists of a range of mathematical skills to be developed including those of calculation, algebra and statistics, and also a set of soft skills (including study skills), report writing and research skills, presentations, team working and self-management skills. This helps to strengthen the student as a self-regulated learner and also addresses many of the 'top-five' skills evidenced in Table 1. Thus the module has two functions: to assist students in becoming more effective at organising their own learning while on the course, and to extend these skills into the work of the management accountant.

Teaching on the module also allows students to develop and test their core skills. Student learning is an active process benefiting from the engagement of the students, their peers and staff alike in partnership and providing academic challenge through formal lectures, guest speakers, activities such as discussion, group work and debate based around case study, PowerPoint presentations, research activities and role-play. In addition there is extensive academic support and guidance and formative assessment and opportunities for students to engage in reflection and personal development planning.

The approach outlined above is a new departure in the way that mathematics is taught to these students. In assessing the impact of this approach the relatively small class size and the need for an equitable student experience on the module argued against partitioning the group into a 'treatment' group and 'control' group as a conventional experimental design might suggest. Instead the research considered student feedback as indicators of success that might encourage the roll-out of this approach to other larger groups of accounting students in the future. The students were, however, asked to repeat the RMARS questionnaire once the Professional Skills module had been completed. The boxplot showing the distribution of total anxiety scores at the start and the end of the module is shown in Figure 4.

The average change in total anxiety per student between the two test points is -6.7 showing a general reduction in mathematical anxiety. Comparing the two distributions using the non-parametric Wilcoxon signed rank test for paired data leads to a rejection of the null hypothesis that the median difference between the paired observations is zero (p = 0.008, two tailed test).

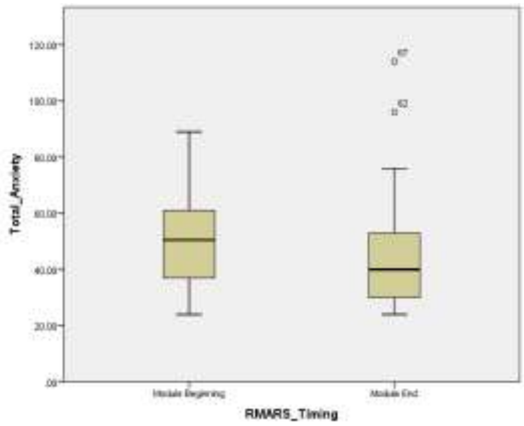

Figure 4: Change in total anxiety scores

Although this is evidence to suggest then that students' anxiety levels were reduced by the end of the module the statistical test alone cannot say anything as to why the reduction was observed as there may be several reasons for this just one of which may be the pedagogic approach. To gain further insight into students' perceptions qualitative feedback was examined for the Professional Skills module. These comments derive from the university's standard module evaluation process which all students are asked to complete. Table 6 illustrates the comments offered by students purely in relation to quantitative skills. Students were not asked specifically about quantitative skills in the evaluation, but were asked to give examples or what was good about the module and what needed improvement. The fact that students mention the mathematical content in a positive context and only one student commented negatively indicates that the module has been well received by the students. It was also interesting to note that 74% of students agreed that the assessment load for the module was appropriate to its content and 78% agreed that assessment was varied and useful. Given that 'assessment in mathematics' and 'active mathematical engagement' were identified as primary causes of mathematical anxiety the positive response of students in module evaluation is perhaps indicative of some success in building confidence and reducing anxiety in mathematics.

Table 6.

Qualitative student feedback relating to quantitative skills

	Positive Comments	**Negative Comments**
These comments are derived from the module evaluation process. In general, 78% of students agreed that their experience of the module was good, 74% agreed that the seminars and workshops were of a good quality, and 78% agreed that the assessment was varied and useful.	**Student A**: My experience of this module was good … after a few years out of education my maths was basic. **Student B**: It really helped me to know my skills better and how to improve them including maths. **Student C**: Maths. I have picked up the skills that have helped me become a better and more efficient individual. **Student D**: I have improved my Excel skills, …, and maths. **Student E**: I have gained mathematical skills. **Student F**: From studying this module I have learned to work in a team and have a better knowledge about some topics in maths.	**Student G**: … the way that maths is taught. For example the teacher should go through more examples…

Can educators do more? In this respect a further survey of recent literature has identified a variety of studies that have attempted to tackle mathematical anxiety issues (although not in the context of accounting education) and could thus be explored further in the context of our skills module.

Approach 1 – Flipping the classroom

Wilson (2013) considers an approach to statistics teaching which involves a flipped classroom. In this study class contact time relating to the more typical 'transmission of knowledge' aspects of the module were very much reduced and replaced with activities that focussed on 'application of knowledge'. Theoretical knowledge was developed prior to the formal classes using a variety of educational media with the incentive to students that online quizzes based around the material contributed to summative assessment of the module. Students were also assigned into learning groups that provided a support network for students for in-class activities and also for other statistical assignments. Module evaluation provided evidence that the changes made by flipping the classroom met the required objectives of improving the student experience and the student perceptions of both the module itself and the tutor. Student achievement also improved indicating that the barriers to student learning such as mathematical anxiety had been reduced. Wilson makes the point that students being able to 'do statistics' in an environment where they can get immediate feedback "… not only enhances their learning of their material but also serves to decrease their anxiety, as they see that there are resources available to help them when needed." (Wilson, 2013, p. 197).

Approach 2 – Improving student perceptions of mathematics

Wismath and Worrall (2015) describe an approach to mathematics development which distinguishes between mathematics as it is traditionally envisaged, and quantitative reasoning. While the former is concerned with the building blocks of theoretical knowledge that can take the student to the required levels of technical proficiency in the subject, the latter is concerned with those elements of mathematics that are required to turn a student into a "… functioning consumer and citizen in a technological age." (p. 2).

Their empirical study investigated whether a specifically designed quantitative reasoning course produces improved student perceptions of mathematics particularly in relation to confidence, anxiety and the value of mathematics. The course itself covered a range of disciplinary areas dealing with the history of numbers, number systems and number representation and led to applications of number in finance with the associated study of models, graphs, functions and statistics.

Results of the single semester module were impressive in that they were able to demonstrate increased confidence and decreased anxiety among students by the end of the module that was statistically significant. The authors believe that running a course such as this can have a significant impact on the mathematical education of non-mathematics specialists.

Approach 3 – Coping with anxiety

In a study of pre-service teachers in Canada Finlayson (2014) addresses both the causes of mathematical anxiety as experienced by the teachers themselves, and also some of the mechanisms through which the teachers have attempted to combat anxiety. This focus on the individual and the types of coping mechanisms employed can give indications as to how classroom practice can be evolved to help mathematically anxious students. Primary data collection from the teachers unearthed a range of perceived causes of anxiety that included a lack of self-confidence, fear of failure; teaching styles; ineffective learning practices, and non-engagement with the subject. Of these the most common causes were the teaching style experienced, a perceived lack of knowledge and a lack of self-confidence.

Moving on to explore how anxiety can be dealt with the teachers identified such things as diverse teaching approaches, a slow pace of teaching, encourage risk taking, practice, and engage the students as positive actions to reduce anxiety.

In terms of how these elements might be put into practice the study suggests that mathematical anxiety can be addressed by providing a constructivist teaching environment for students. Learning should be interactive with a focus on the problem solving process so that students might be working in groups on problem-solving activities so that discussion about solution strategies is encouraged and questions can be asked. Mathematical understanding would be constructed and demonstrated in many ways including mathematical structures, diagrams, symbols, narrative, and real-life examples. Assessment processes should be varied and might include formal testing, but should also encourage the use of observations, portfolios, journals etc. Such approaches would empower students to take risks with mathematics, not be afraid to make mistakes and would actively engage students in real applications of mathematics.

Conclusions and Further Work

This paper has begun the process of examining the extent and causes of mathematical anxiety among our accounting students. This study has found that there is evidence to confirm the existence of mathematical anxiety among new students particularly related to assessment processes and to the active engagement with mathematics in the classroom. Also it is strongly correlated with student performance in a diagnostic mathematics test which suggests that educators can enhance the performance of their students by working with them to reduce their mathematical anxiety and hence improve their engagement with mathematics and mathematical techniques. The particular approach to developing core mathematical skills described in this paper coincides with reduced anxiety experienced by students but there is a need to conduct further research in this area to get a better idea of the pedagogic mechanisms at play and to see how learning and teaching processes can be further improved. This evidence however needs to come from the students as it is their requirements that will, to a certain extent, dictate the particular aspects of mathematical learning that need support.

In addition, there is a need to explore other modes of teaching (perhaps with the inclusion of blended learning and online support activities) to see specifically how these interventions impact on the student experience and mathematical anxiety. Also module content needs to be refined to achieve that optimal balance between knowledge acquisition and skills development (Becker, 2013), and current research such as that by Beaumont, Moscrop and Canning (2014) on dialogic approaches to student feedback that support self-regulated learning need to be explored.

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