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Engaging Business Students in Quantitative Skills Development

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ABSTRACT

In this paper the complex problems of developing quantitative and analytical skills in undergraduate first year, first semester business students are addressed. An action research project detailing how first year business students perceive the relevance of data analysis and inferential statistics in light of the economic downturn and the challenges society faces is discussed. Students' attitudes were evaluated via an online survey consisting of both quantitative and qualitative responses. While two thirds of respondents do acknowledge the relevance of such a course for future business roles, it is shown that more work must be done to distinguish between why data analysis is relevant and how data analysis is performed. Also discussed are findings related to student learning, their intellectual development, and their motivation and expectations upon enrolling on the 'Data Analysis for Decision Makers (DADM)' module. The challenges in teaching such a mandatory module to Business students are discussed and a pedagogical framework for promoting deeper student engagement through active learning, regular continuous assessment and technology are also examined.

Keywords: Business education; data analysis; transition; motivation; engagement; learning; assessment strategies.

Introduction

Lunn argues that disadvantageous consumer decision-making (in relation to financial products) was probably instrumental in both the Irish and global financial crises, Lunn (2012). He argues that the lack of ability to assess risk was a factor in poor consumer decision-making. Lunn suggests that government policy and education programmes could improve consumer decision-making practices in this area. As the numbers of students attending courses in mathematics and statistics continues to increase, mainly due to the recent stress placed on the importance of STEM subjects to society (Engineers Ireland, 2010; Expert Group on Future Skills Needs, 2008), a significant number of first year students are not adequately prepared in terms of their mathematical background and skills to meet the demands required by such courses. Before business students can assess risk, they have to understand probability.

The restructuring of undergraduate business degree programmes at X, Ireland in 2011 identified quantitative and analytical skills as central to the holistic education of business students. One key aim was to foster sound decision-making practices based on data analysis and this skill was viewed as essential to the business leaders of the

future. The review involved consultation with key stakeholders and identified three programme pillars: business in society, innovation and enterprise, and personal development planning.

Goals for the revised business programmes using the Joint Quality Initiative Dublin Descriptors specify the general expected attributes of students who complete the programme, JQI (2004). Dublin descriptors consist of a set of criteria phrased in terms of competence levels. The descriptors were devised as part of the Bologna process to develop national frameworks of qualifications. From this process, the European Credit Transfer System evolved, a standard for comparing the study attainment and performance of students of higher education across participating European countries.

One programme goal, under the theme of discipline knowledge, specifies that graduates will be well grounded in the theory and practice of business management and related areas. Under the theme of *analytical skills*, another goal specifies that graduates will be able to identify and comment critically on business and social issues. In particular, students should "have the ability to gather and interpret relevant data (usually within their field of study) to inform judgements that include reflection on relevant social, scientific or ethical issues".

Data Analysis for Decision Makers (DADM) was designed during this review as a module to address these two goals. Business programmes traditionally include a business statistics component that focuses on the application of statistical methods. DADM is the application of statistical techniques to describe and explore a set of data. One of the core aims in the delivery of the module is to use data analysis to highlight useful information that aids decision-making. DADM is a core module for all (circa 550 per annum) undergraduate business students and is delivered in semester 1 of first year. Statistical thinking and literacy skills are key in their future roles in the business world. The module learning outcomes are described in Section 3.

In delivering the DADM module, activities and supports that enable students meet the learning outcomes are used. In AACSB (2006), the authors suggest that business school graduates are good at doing sound technical analyses, but that they have difficulty in applying that analysis to effective decision-making. This report is US based but the claim could equally be applied to Irish business students. Business students often demonstrate a competent knowledge of analytical and statistical procedures but find explaining what the results mean challenging.

Students perceive maths as hard and business students in particular perceive data analysis and statistics as boring and irrelevant to the real world, McAlevey and Stent (1999), Gougeon (2004), Murphy (2010). There is a significant challenge to engage business students with quantitative topics and convince them of the relevance of these topics to their future careers in the business world.

The DADM delivery philosophy aligns with the GAISE recommendations on how to teach an introductory college statistics course, (ASA 2005). The GAISE recommendations are:

1. Emphasize statistical literacy and develop statistical thinking;
2. Use real data;
3. Stress conceptual understanding rather than mere knowledge of procedures;
4. Foster active learning in the classroom;
5. Use technology for developing conceptual understanding and analysing data;
6. Use assessments to improve and evaluate student learning.

An action research project was undertaken to determine whether business students thought the statistical thinking and conceptual understanding skills offered in DADM

were relevant to business. A number of themes emerged in the course of that research. In this paper the following research question is addressed:

Do business students think that DADM skills are relevant to business people?

Literature Review

Student intellectual development

In Perry's model of cognitive development, students progress through different developmental stages or positions. In the first position, students see the world in black and white terms, where correct answers exist to every question, and the answers are known to someone in authority, such as the lecturer, Perry (1970). While modern Irish students may not have the same respect for authority, they still expect the lecturer to know (and direct them to) the right answer.

In Perry's final stages of development, students progress toward an understanding that knowledge and values are relative. Decisions on what become personal values are part of an ongoing unfolding activity in which the student actively engages.

West summarises different schools of thought into a gender-neutral 4 stage model for intellectual development, West (2004). Such works give us a framework under which one can attempt to understand how students are developing, so that teaching can be appropriately tailored. These models and frameworks give us some insight into the challenges facing both lecturers and students, Perry (1970), West (2004).

The challenge for educators in the DADM module is to assist the student to develop a deeper level of understanding. The wish is to enable students to move beyond the black-and-white correct answer mentality toward a more mature reflection on what the answer means in a given context. Asking first year undergraduate students to analyse and interpret the outputs of a piece of statistical work is very different to asking them to perform the statistical task.

In DADM coursework, students are asked to apply data analysis techniques and interpret the solution. It is imperative to shift their focus from calculating a solution value to interpreting what the solution might mean in a particular business context. Given a set of numbers, students are within their comfort zone in calculating the answer. This task is black and white in the sense that there is one correct formula that should be used and one correct answer. In general, students have performed such tasks in their maths courses at secondary school. In terms of Bloom's taxonomy, students perform well in applying their knowledge to tasks that require them to calculate a numeric answer, Bloom et al (1956).

In pushing them into a grey area by asking them to explain the numeric solution and its meaning (or recommend a course of action or examine the differences between data sets) for a decision-maker, students perform less well than if asked to perform the statistical test. A common cry from students in response to open assignment tasks is '*Tell me what to do*'.

Student Expectation

We have noted the perception that students expect to be led to the right answer. Students' expectations of higher education depend on a number of factors according to Sander et al. (2000). The authors suggest that students perceive themselves as customers and that new undergraduates may have unrealistic or inappropriate expectations. Their research shows that students expressed a preference for interactive lectures while expressing a dislike for formal lectures. They also describe the Expectation Led Planned Organisation (ELPO) model that encourages the formation of partnerships with students to negotiate the most effective teaching and

learning methods. It is thought provoking to consider whether first year students are ready to participate in such a partnership.

Students need to be prepared for their new roles at university, Taylor (2000), Barefoot (2006). Taylor notes that the preference from some early stage students is the traditional lecture, Taylor (2000). Taylor argues that students are likely to either resist their new roles as self-directed learners, or to express considerable dissatisfaction because their expectations were not met. He suggests that early stage students have not yet developed their abilities to engage in flexible learning strategies.

Additional challenges faced by students to engage in meaningful self-directed learning, are outlined by Metcalfe and Kornell (2003). The authors note that effective time management and study skills as well as awareness of students' own learning styles play a role in self-directed learning. The role of student study time and its impact on academic performance are described by Masui et al. (2012). The authors note many issues in determining how study time affects performance. Students must decide how to allocate their study time.

Further challenges exist to ensure that the expectations of achievement and behaviour are the same for all students, Tinto (1993). Tinto warns that in making higher education appealing to all who enter, we would make that education of little value to anyone who obtains it, Tinto (1982). The analysis below shows that some students on the business programmes struggle to adapt from a secondary school teacher-led learning environment to a student-centred university learning environment.

Hourigan describes the impact of exam-focused secondary school teaching in Ireland on the preparedness of students to make a successful transition to university, Hourigan and O'Donoghue (2007). Continuous Assessment can be used to help students shift their focus from a teacher-led expectation. McAlevey notes that coursework in statistics-based courses may be particularly useful to students with humanities type backgrounds, McAlevey and Stent (1999). As noted in Taylor (2000) and O'Neill et al. (2005), a clear message is needed to explain what is expected from students engaged in autonomous student learning. This clarifies the roles and responsibilities of the partners in the university learning environment and can help to manage student expectations.

Student Motivation

The rationale for placing DADM in semester 1 of first year was so that students can make use of these skills and judgements throughout the rest of their time in university. The aim was that these skills should inform their thought process throughout later modules. Linked to this and the research question was an interest in knowing what motivates students to learn.

Some authors suggest that certain assessment strategies promote better student learning engagement than others, e.g., Murphy (2010). Entwistle asks which forms of teaching and assessment evoke interest, Entwistle (2002). He suggests that methods that evoke student interest promote a deeper approach to learning among students and deeper levels of conceptual understanding. He suggests that what students learn depends on how they learn, and why they have to learn it. He suggests that an acceptable workload and open assessment formats seem to help foster deep learning, but that the strongest effects come from the quality of teaching and the design of learning materials.

Biggs also believes that students approach learning in different ways depending on the factors that motivate them to learn, Biggs (2012). Biggs found that students adopt a surface approach to learning in order to avoid negative consequences such as failing. Ames considers that it is primarily the responsibility of teachers to motivate children to

learn, Ames (1990). However, as noted in the *student expectation* section, university students are expected to be self-directed learners. The lecturer's role in fostering student engagement is to provide a constructive learning environment and quality learning resources, Tinto (1982).

Students who are focused on *'not failing'* may not see the interconnections between the DADM material and the wider business world. Dweck (1986) speaks about two conflicting mindsets when it comes to motivational behaviours to learning: the *fixed mindset* of the person who wishes not to fail at all costs, and the *growth mindset* of the person who wants to learn at all costs. Students may not perceive the value of the quantitative skills on offer in the DADM module if their only motivation is to pass the module. It is a significant challenge to persuade students that these skills are relevant to their future careers as business leaders. Some of these challenges are described next.

DADM: Learning outcomes and challenges

The DADM module was designed to ensure that students would be able to complete the following tasks upon successful completion of the module:

1. Prepare spread-sheet models to store, manipulate and analyse quantitative data using common probability distributions and statistical functions,
2. Calculate, analyse and present useful statistical measurements from large-scale data sets,
3. Create and interpret inferential statistical statements about population parameters,
4. Interpret the results of data analyses with a view to informing decision making.

As noted earlier, unfortunately, business school students generally dislike statistics-based courses. Gougeon notes that students perceive statistics courses to have little practical value and to be extremely difficult, Gougeon (2004). Several authors note the unique challenges faced by educators in business schools as students often lack interest or motivation to perform to their full potential, McAlevey and Stent (1999), Gougeon (2004), Rochelle and Dotterweich (2007), Yilmaz (1996). Many authors have described attempts to engage and motivate business students in statistics and critical thinking education, e.g., Green et al. (2009), McAlevey and Sullivan (2001).

The use of secondary school-type classes for teaching mathematics and statistics to college business students compared to traditional lecture and tutorial methods are described by Goldfinch, (1996). Subjects such as statistics are mastered by practicing on problems. The author points to the need to master techniques early in such courses, otherwise subsequent achievement is "well nigh impossible". The benefits of small-class teaching are outlined. Unfortunately economic factors do not currently allow for classes as small as 20 as described by the author.

Issues of teaching students in large groups are addressed in Biggs (1999), Surgenor (2010), Waddington and McCaffery (2010) and Waddington et al. (2010). Other authors have addressed the challenges for academics engaged with students who have grown up in the Internet age. Jonas et al. argue that academics now need to be able to communicate with students through a range of media, and to interact and provide support 24 hours a day, seven days a week to meet student expectations of a technology-enhanced education, Jonas-Dwyer and Pospisil (2004). The authors characterise the millennium generation (those born after 1982) as confident, goal oriented and technologically savvy. They argue that students of this generation exhibit distinct learning styles leaning towards preferences for teamwork, experiential activities and the use of technology. Price notes that undergraduate students are more technologically savvy than ever before but that this does not necessarily translate into information literate students, Price et al. (2011).

It is of note that exposure to technology does not always translate to technological skills and that students may not be as technologically literate as we expect.

Issues of attendance are discussed in Cleary-Holdforth (2007) and Tinto (1993). Students are more likely to attend lectures they consider to be interesting, relevant, and delivered in a positive manner, Cleary-Holdforth (2007). Students are less likely to attend when lecture material is available in online forms, timing of lectures is unattractive to them (for example; Mondays and Fridays) or they have competing assignment deadlines.

Tinto cautions that there are limits to what social theory can explain, he notes that models and frameworks can only explain a portion of the wide range of behaviours that constitute the universe of social interactions and that this is particularly true in relation to attendance and engagement behaviours in higher education, Tinto (1993). Non-attendance and dis-engagement are particular concerns in modules such as DADM where the content builds incrementally over the course of the semester.

Students come into business programmes with a wide variety of mathematical abilities, Goldfinch (1996). The state end of secondary school exam in Ireland is the Leaving Certificate. A minimum of a B3 (70-74%) at ordinary level (or D3 (40-44%) at higher level) in the Irish Leaving Certificate Maths exam is stipulated as an entry requirement to the X business programmes. The majority of entrants to business programmes in X come via this access route (88% in 2012). Students who sat the Leaving Certificate in 2012 were the first cohort to have come through the *Project Maths* Strand on Probability and Statistics. Project Maths is an initiative by the Irish education authorities that involves the introduction of revised mathematics syllabuses at second level to improve the mathematical ability of school leavers. It aims to address some of the mathematical under-preparedness of secondary school students described in Hourigan and O'Donoghue (2007). For a treatment of the preparedness (or otherwise) that this Project Maths syllabus offers Business students, see Cronin and Carroll (2013). Equivalent entry requirements are stipulated for other access routes.

The challenges outlined in this section resonate with the instructors' experience in DADM, and as will be seen below, the data confirms some of the findings from other studies also.

DADM Delivery approach

The module is delivered through a weekly two-hour lecture in large groups (circa 150) with a follow-on tutorial in smaller groups (circa 50). The principles of *Active Learning* (AL) are used in DADM face-to-face contact time. AL can be defined as a process of keeping students mentally active in their learning, through activities that involve them in gathering information, thinking and problem solving. There is a growing evidence that this approach is effective, Michael (2006).

A small example of a business problem is used during lecture time as the basis for developing theoretical concepts. Students are then asked to engage in class exercises to solve similar problems and interpret their solutions. Students are encouraged to work with their peers during these activities though some choose to work alone.

DADM also employs eLearning and ICT resources extensively which students can access online at any time. The Articulate Storyline eLearning authoring software was used to develop the eLearning content, Articulate (2013). Captivate was also used to record "How to" demonstrations in Excel, Adobe (2013). Blackboard is the learning management system used in X through which eLearning content is made available.

Students are instructed to attempt online short exercises after lectures in advance of tutorials. Answers to the online exercises (and feedback on calculations steps) are given when a student submits an attempt. The short exercises focus on methodology and demonstrate the steps in formulating and solving problems. Students can attempt these exercises as often as they like. Students are encouraged to use these as practice exercises. There is no continuous assessment (CA) mark awarded for attempting these online exercises. At tutorials, teaching assistants review student progress with the online exercises, responding to student queries and clarifying concepts.

At the end of each section of the module, online review and more extensive case study exercises are available for students to work through in their own time. *Theory into Practice* (TIP) exercises focus on sample business applications and demonstrate the applicability of data analysis within a business context. Open source data sets are used where possible. Sample analysis and interpretation are given as feedback when a student submits an attempt.

Additional supports are also offered in the form of DADM drop-in clinics, access to the X Maths Support Centre (MSC), MSC sessions in discrete and continuous random variables and additional training in Excel. The intention is to facilitate different student learning styles and abilities so as to enable students to engage fully with the learning process. Every effort is made to engage students using the styles of learning that they prefer while maintaining academic rigour with respect to the content. This provides a very different learning environment to the secondary school classroom.

Assessment strategies

As noted earlier, a variety of assessment methods can promote deep learning approaches among students. In DADM, grading criteria are used to quantify to what extent individual students have met the learning outcomes as evidenced by their performance on the assessment tasks. A summary of the DADM assessment tasks is shown in Table 1.

Table 1: *DADM assessment*

CA Item	Weight	Comment
Excel work	3%	Spread-sheet exercises completed in tutorial
Excel test	12%	Data Analysis using Excel
2 MCQs	15%	Online - Covering theoretical and practical concepts
Team Project	10%	Open-ended project. Given a small business data set to analyse - write management report with recommendations
Exam	60%	Traditional two hour written terminal exam

The assessment strategies are designed in line with the Dublin Descriptors, JQI (2004) to test if students can apply their knowledge and understanding of data analysis to solve problems within the field of business. In particular, the team project assesses whether students have the ability to gather and interpret relevant data to inform judgements and reflect on a specified business topic. It offers students the opportunity to bring together all the ideas from the module and use their data analysis skills to reach conclusions about a contextual business problem. Using *Statistics Tracking* on

Blackboard, there is evidence that students employ a *Just-in-Time* strategy to prepare for their next assessment.

Research Methodology

This paper is based on reflecting on over ten years of practice in delivering the DADM module. These reflections include making the transition from the 'passive' pedagogical format of the traditional lecture model to a more 'active' method of teaching which seeks to engage the student.
Ethical clearance to conduct this action research project was sought and obtained. Both quantitative and qualitative data were gathered in an attempt to answer the research question posed in the introduction. An online survey to ascertain students' attitudes toward the DADM module was implemented. The survey contained a mix of five-point Likert items and open-ended questions. The Likert items were scaled from 'Strongly Disagree' = 1 to 'Strongly Agree' = 5. Using this scale, the more students agree with a statement, the higher the Likert average. A copy of the survey and anonymised data are available at the following webpage
http://www.ucd.ie/t4cms/Survey_final.pdf

The survey was optional and delivered via Blackboard. A pilot pen-and-paper survey was run in week 8 of semester following which minor changes were made to improve the readability of the survey. The full survey was made available to students from week 11. Of the 540 students enrolled in the module at the end of semester 1, 127 responded to the invitation to participate in the survey. We note that this response rate of almost 24% is low in social scientific terms, and also that not all respondents answered all the survey questions.

Analysis and Findings

It is important to stress the pitfalls of online surveys, Couper (2000), Dillman and Bowker (2001), Umbach (2004). These authors note that online surveys can be subject to bias. In the case of DADM, 62% of the students in the module were male, 38% female. Approximately 88% of students came directly from the Irish secondary school system in 2012, with 70% of these having taken the Leaving Certificate Higher Level Maths Option. The balance were students from non-business schools taking the module as an elective, and a small number of students entering through mature or disability access schemes (approx. 5%).

The profile of survey respondents was 47% male and 53% female, which is statistically different from the class profile at a 0.05 level of significance. 66% of survey respondents who had entered the programme from the Irish secondary school system had taken the Leaving Certificate Higher Level Maths Option. This is not statistically different from the module student profile. The students' Leaving Certificate maths grade (for the students on this access route) was used as an indicator of their quantitative skills on entrance. In summary, the survey sample is biased toward the female students, but does not show any bias toward quantitative ability.

The survey responses give us a snapshot of the participants' frame of mind and perception of the DADM module at the time they completed the survey. The results have not been adjusted for nonresponse error and are presented here, warts and all. The survey was available at the end of semester in the weeks leading up to the final exam. The timing may have coloured the view of participants. Many students only engage toward the end of semester when the exam focuses their attention. This often means they have a high workload to catch up on. A number of themes emerged in response to open questions in the survey. In this article we concentrate on those that answer the research question.

Do business students think that DADM is relevant to business?

Students were asked to reflect on their experience with Data Analysis for Decision Makers, and to indicate if they thought the skills and understanding developed were relevant to consumers, people in business, scientists or engineers and government or public body policy makers. Students could select all categories they considered relevant. 86% of survey respondents answered this question. Their responses are summarised in Table 2.

Skills in the DADM module were perceived to be relevant to the business category by 66.14% of respondents. Over one third thought the set of skills relevant to government policy makers, and interestingly only 22.5% thought the DADM skills relevant to the consumer. It is noteworthy that Lunn has suggested a lack of these skills among consumers contributed to poor financial decision-making and contributed to the global economic collapse, Lunn (2012). As noted by Tinto (1993), there are limits on how far social theory can go in explaining human behaviour.

Table 2: *Student perception of the relevance of DADM skills*

Category	Considered relevant
unanswered	14.17%
Consumer	22.05%
Business people	66.14%
Scientist or Engineer	44.09%
Government Policy maker	33.86%

The survey's open-ended questions however revealed some strong negative sentiment toward the module. Students said: "not once did we use a business application, this [module] should be associated with a maths degree or people specialising in consumer statistics", "In my opinion the data analysis module should be struck off the business programmes in X as they are a complete waste of time and appeal to about 2% of the classes (sic) interests." and "I and my fellow students found the module completely useless and a waste of time."

While only three respondents made such strongly negative comments, it is striking how intensely these students feel that DADM is inappropriate for business students. The last comment is particularly interesting in that students often claim that no one in the class understands any of what is going on. This claim is not supported by the assessment results, 84% received a passing grade or higher in 2012. It may indicate a group think experience particularly for students with weaker quantitative skills.

An additional 10 students commented that they had found the DADM module hard or difficult, which corresponds to the findings of Gougeon (2004) and Murphy (2010).
"I find it extremely difficult even though I have not missed that many lectures". We have no insight from this comment about why the student missed lectures, or what they consider to be "many", or indeed if they would have found it any less difficult if they had attended all lectures. We had set out to persuade students that DADM was relevant to them as future business leaders. Just under two thirds of responses indicated students perceived a connection between DADM and the business world.

Conclusion

In this paper we have described an action research project conducted with first year undergraduate business school students. We wanted to know: whether business students thought that the core Data Analysis for Decision Makers (DADM) module was relevant to business people.

This aspect of the action research project focused on student attitudes. The survey responses are consistent with earlier work in this area. They indicate that the global financial crisis has had little impact on changing the perceptions of business students as to the relevance of data analysis as a tool to aid decision-making processes.

Over 84% of students enrolled in DADM achieved a sufficient level of understanding to pass the module and this is encouraging for their roles as future business leaders. However, more can be done to improve engagement and aid student quantitative skills development. The survey responses showed that students found the DADM module challenging. If the university experience is about pushing the boundaries, we should not be surprised that first year students find this a dis-comforting experience for which they do not thank us.

We have noted the motivational effects of the continuous assessment tasks that correspond to the findings of other authors e.g., Dweck (1986), Entwistle (2002) and Biggs (2012). Regularly spaced continuous assessment tasks can encourage students to stay on top of their study workload. We caution against an over reliance on continuous assessment tasks which may only promote a surface learning approach, this learning strategy was sometimes apparent from students' just-in-time approach to the tasks. Offering continuous assessment tasks to first year students seems to motivate students, but students need to be weaned off continuous assessment as their main motivator as they develop into their roles as independent learners. We note that considerable administrative and academic effort was involved in setting up and running the variety of continuous assessment activities described for the large group of students registered on the module. As noted, web-based surveys may contribute to sample bias and the survey response rate was low.

Making the links between *why* and *how* seems to be the stumbling block for many students in progressing through the different developmental stages described in Perry's model. To this end, a DADM initiative involving short lectures on relevant data analysis topics from guest industry stakeholders is in train. The rationale here is to help facilitate students in forming a more positive view of the relevance of data analysis to business roles. The guest lectures are short case studies in *why* data analysis is relevant rather than *how* data analysis is performed.

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