An exploratory investigation into the value added through university-based teaching of actuarial science

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Presented at the Actuarial Society of South Africa’s 2014 Convention
22–23 October 2014, Cape Town International Convention Centre

ABSTRACT
Teaching is a vital component of the South African actuarial education system. This paper provides an initial exploratory investigation of the value added through teaching actuarial science in a South African university. The investigation is conducted using responses to a survey questionnaire distributed to actuarial science students attending the University of the Witwatersrand. Relevant research is reviewed to supplement the investigation. This research includes the value added through teaching in the context of a comparable profession, the effects of poorly designed course materials and considerations in conducting a survey questionnaire. The results of the investigation broadly support the continuation of university-driven teaching of actuarial science, but there are key areas of focus that require deeper research.

KEYWORDS
Teaching; conceived value; validated value; university; actuarial science; survey; South Africa

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1. INTRODUCTION

1.1 The Oxford English Dictionary defines ‘teaching’ as “the imparting of instruction or knowledge; the occupation or function of a teacher”.¹ This general definition encompasses the myriad of activities in imparting the instruction, but gives no indication of the value thereof. This paper seeks to investigate the value in the context of actuarial science education in South Africa.

1.2 To date, there exists only a small volume of research with regard to actuarial science education. Moreover, the small volume of literature is based predominantly on theoretical studies and not on empirical analyses. Much of the existing research is driven by policy changes or governance protocols, and not by pure academic interest in the area. This is highlighted by the severe weakness in academic research into actuarial science education as compared to other professions, e.g. accounting.

1.3 The purpose of this paper is to provide an initial exploratory investigation into the teaching aspect of actuarial science. To this end, the following research questions are to be investigated by conducting a survey questionnaire issued to actuarial science students at the University of the Witwatersrand, South Africa:

a) Do teachers add value with regard to students studying actuarial science subjects?

b) How does the value added through teaching differ by actuarial science subject?

c) How does the value added through teaching differ by student cohort year?

d) How does the value added through teaching differ by actuarial science subject for different student cohort years?

e) Are students more likely to succeed in their examinations if they recognise the value added through teaching?

1.4 The content of this paper is arranged as follows: section two provides an outline of the importance of this research for the Actuarial Society of South Africa (ASSA); section three is a review of the available literature relating to the value added through teaching in comparable professional courses; section four contains a review of the available literature relating to the additional difficulty of teaching professional courses with poorly designed course material; section five shows the exposition of the research performed, which comprises an outline of the data, along with appropriately defined measures of teaching ‘added value’, and of the results derived; included in section five is a review of the available literature relating to survey considerations, as the data used is derived from a survey questionnaire; section six concludes the paper.

2. THE IMPORTANCE OF THIS RESEARCH FOR THE ACTUARIAL SOCIETY OF SOUTH AFRICA

2.1 Ascertaining whether teachers are able to add value in the context of university-centric education of actuarial science, as it is considered in this paper, is of particular importance for the profession, and its relevant governing bodies. This is a consequence of the essential role played by universities within the education structure of actuarial science in South Africa. This “strong tradition of local university-based education” (Slattery & Kemp, 2007) is substantiated by the accreditation of certain universities in offering exemptions from many of the qualifying Actuarial Society of South Africa (ASSA) examinations. As at the date of Slattery & Kemp’s (op. cit.) research, compared to almost any other country, there were a greater number of universities in South Africa that offer actuarial science programmes. Although there might have been changes in the global landscape of university actuarial science programmes, this still indicates the extent of the integration of university-based education into ASSA’s qualification process.

2.2 In terms of securing the establishment of a local actuarial qualification by ASSA, as proposed by Slattery & Kemp (op. cit.), universities would be required to assume a vital role within the education of ASSA’s participating student members. Research into the teaching aspect of university education then becomes a critical advantage with regard to any local qualification facilitated by ASSA.

2.3 In addition to being an important component of ASSA’s objectives, there are further proposed advantages in operating a university-based education system, as stated in the Morris Review, which include:

— better syllabus development;
— improved quality of the examination process;
— innovation in research and teaching methods; and
— reduced qualification times.

The final advantage listed above is of particular interest as this is a fundamental attraction to the profession for the best and brightest individuals, as mentioned in the Morris Review, which ultimately benefits the profession and its relevant affected stakeholders. Note that ‘teaching methods’ listed above implies that teaching adds value, which, to date within actuarial science academia, has yet to be tested.

2.4 As suggested by the importance of universities already conveyed above, and the scope for improvement of the actuarial profession through an integrated university-based education system, it is imperative that a thorough investigation into the value-added nature of university-based actuarial education be undertaken.

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based education system, a thorough inspection of the value added by South African universities offering actuarial science programmes is a necessary research development. This paper serves as an initial exploratory investigation into the professional teaching of actuarial science and attempts to answer the core question of whether teaching adds value to actuarial science students in studying ASSA qualification subjects offered at South African universities.

3. THE VALUE TEACHING ADDS IN PROFESSIONAL COURSES

3.1 As suggested in §1.2, there is a paucity of research in the actuarial science education field on the value added through teaching. The authors therefore had to look elsewhere for relevant research on the topic. Fortunately, the accounting profession does a reasonable volume of research on education topics pertinent to accountants—this profession is therefore used as the primary source of literature.

3.2 There is a vast amount of literature on the theoretical value that teaching adds. The authors are more interested, however, on the testing of this within a statistical framework. This reduces the amount of relevant literature substantially, particularly with the focus on accounting as a proxy for actuarial science.

3.3 In 1998, Naser & Peel published research on the significant factors influencing student performance for students attending the Principles of Accounting course at Birzeit University, Palestine. This research was done in a developing economy, which may make the results more congruent with South Africa (Naser & Peel, 1998). The Principles of Accounting course is a first year introductory technical course, so the research results possibly have the greatest meaning for the A1 and A2 level of the Actuarial Society of South Africa’s (ASSA) examination curricula. Finally, the research was based upon the responses to a questionnaire delivered to the Principles of Accounting students and was aimed at the students’ conceptions with regard to the course (Naser & Peel, op. cit.). As the research in this paper is also primarily conception based, this is consistent.

3.4 Naser & Peel (op. cit.) tested “whether students’ perceptions of factors associated with the teacher’s ability, student effort, class size and the complexity of the course and examinations are significantly associated with student performance”. The first basic investigation the authors performed was to test the significance of Spearman’s correlation coefficient between each factor and students’ examination scores (Naser & Peel, op. cit.). Using this measure, the authors found that the primary value that teachers add is in stimulating students’ interest in the course (Naser & Peel, op. cit.). The teaching effectiveness of the lecturer was found to be significant at the five percentile level (Naser & Peel, op. cit.). Interestingly, the teacher’s knowledge and the quality of

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the teacher relative to other teachers were found to be insignificant at comparative significance levels (Naser & Peel, op. cit.).

3.5 Naser & Peel (op. cit.) then applied a stepwise regression to alternatively determine the significant factors influencing student performance. Whilst this approach does provide greater explanatory power, this paper questions its credibility given the small class size of only 150 students (Naser & Peel, op. cit.). The results of the regression did, however, reinforce the conception that the primary value that teachers add is in stimulating student interest in the course (Naser & Peel, op. cit.).

3.6 Naser & Peel (op. cit.) warned that there might be bias in their research. As students responded to the questionnaire after they had sat the final examination, their views on the significance of factors might have been influenced by their perceived examination performance (Naser & Peel, op. cit.). The authors of this paper believe that the effect of this may be significant and, as a result, decided to conduct the survey questionnaire before the final examinations sitting, where possible.

3.7 In 2003, Paisey & Paisey published research on students’ attendance in Financial Accounting at a Scottish university. One of their primary research questions was whether students’ attendance at lectures and seminars improved students’ academic performance (Paisey & Paisey, 2003). Whilst this was strictly not research on the value added by teaching, the authors of this paper argue that teaching would be a large portion of the course structure and therefore attendance can be treated as a reasonable proxy for teaching.

3.8 The Financial Accounting course that Paisey & Paisey (op. cit.) based their research on was a compulsory third year accounting module. Paisey & Paisey (op. cit.) pointed out that research done at a first year level would be difficult to interpret, given the number of external factors that influence attendance, such as adapting to the step up from the schooling system. This comment would therefore also apply to the research done by Naser & Peel (op. cit.) and provides an additional concern on the regression analysis performed therein, as described in ¶3.5. Paisey & Paisey (op. cit.) also indicate that an investigation at the Honours level would be inappropriate, due to the natural self-selection of students at that level, i.e. the voluntary selection of students who would most likely be self-motivated and able to succeed in higher-order thinking subjects. Therefore the results of this research would possibly have the greatest meaning for the A2 level of ASSA’s examination curricula.5

3.9 Paisey & Paisey (op. cit.) performed two types of investigations. The first type was a questionnaire issued to students during class time, rather than after the examinations (Paisey & Paisey, op. cit.). This should have mitigated some of the bias discussed

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in ¶3.6. The questionnaire attempted to link attendance to academic performance through a combination of closed- and open-ended questions (Paisey & Paisey, op. cit.). The second type of investigation was a statistical test of Pearson's correlation coefficient between actual attendance and academic performance (Paisey & Paisey, op. cit.). Whilst the Pearson's correlation test is elementary, the authors of this paper believe it is a more credible method than more complex approaches, due to the class size of 68.

3.10 From the answers to the questionnaire, Paisey & Paisey (op. cit.) found the following generic results regarding the benefits of attendance to be the most common:
— increase in students’ knowledge;
— improvement in students’ understanding of the course specific areas;
— ensuring that students had the full course material; and
— help with students’ examination preparation.

As discussed in ¶3.7, the authors of this paper assert that attendance is a reasonable proxy for teaching. The second type of investigation showed that both the examination performance and overall performance, which included coursework, were statistically significantly positively correlated with attendance, at the five percentile significance level (Paisey & Paisey, op. cit.).

3.11 In 2007, Guney published research on the significant factors influencing performance for undergraduate students who took a core accounting module at a British university’s management school. As these were undergraduate students attending core accounting modules, this would usually suggest that the research results possibly have the greatest meaning for the A1 and A2 level of ASSA’s examination curricula. There is a major distorting effect, however, in that Guney’s (2007) research was done on a sample of students whose primary career path was not accounting, i.e. non-specialist students. As this paper is focused on specialist actuarial science students, this would make the research less applicable than that of Naser & Peel’s (op. cit.), as discussed in ¶3.3. Nevertheless, the authors of this paper do assert that the major conclusions of Guney (op. cit.) can be applied to actuarial science students in generality.

3.12 Guney (op. cit.) used a backward stepwise regression to determine the significant factors influencing student performance. Factor analysis was done to statistically reduce the number of factors in the regression model in accordance with an acceptable degree of explainable variation (Guney, op. cit.).

3.13 Guney (op. cit.) referred to Naser & Peel’s (op. cit.) research as the nearest in type. Guney (op. cit.) did, however, mention key differences between the two papers:
— Naser & Peel (op. cit.) researched students at a university in a developing economy, as mentioned in ¶3.3; this makes Naser & Peel’s (op. cit.) research more applicable for the purposes of this paper.
— Naser & Peel (op. cit.) researched specialist accounting students sitting the Principles of Accounting examination, as mentioned in ¶3.3; again, this makes Naser & Peel’s (op. cit.) research more applicable for the purposes of this paper.
— Guney (op. cit.) included more factors in the regression analysis. This should improve the explanatory power of Guney’s (op. cit.) regression model, but at the cost of a reduction in the parsimony of the model.

3.14 In contrasting both papers further, however, there are additional important differences between the two papers:
— Guney’s (op. cit.) student sample size of 357 students was more than twice that of Naser & Peel’s (op. cit.), read to ¶3.5.
— As a result of the larger sample size, Guney’s (op. cit.) regression analysis, as described in ¶3.12, is potentially more credible.
— Guney (op. cit.) did not perform a simple correlation analysis between student performance and the included model factors. As discussed in ¶3.4 and ¶3.9, the basic correlation approach is possibly more robust given the small sample sizes.
— Naser & Peel (op. cit.) only considered a first year undergraduate course, as mentioned in ¶3.3, whereas Guney’s (op. cit.) research covered all undergraduate years, as mentioned in ¶3.11. As discussed in ¶3.8, this would make Guney’s (op. cit.) research more applicable for the purposes of this paper.

3.15 Guney (op. cit.) found that the factor ‘lecturers and assessment’, after reduction, which included teaching quality and availability of lecturers and lecturers’ attitude towards students, is a significant positive contributor to students’ performance, at the one percent significance level. Furthermore, the reduced factor ‘teaching material’, that included non-examination assessments and tutorials, was also a significant positive contributor, but only at the ten percent significance level (Guney, op. cit.). The significance of teaching quality appears to contradict Naser & Peel’s (op. cit.) findings, as discussed in ¶3.4. Although a view could be provided on which of the research efforts the authors of this paper find more compelling, the specificity of each of the research makes a firm conclusion difficult.

3.16 In congruence with the research conducted by Paisey & Paisey (op. cit.), Guney (op. cit.) found that attendance was a significant positive contributor to students’ performance. The proxy argument posed in ¶3.7 is, however, less necessary for Guney’s (op. cit.) research, as the specific teaching related factors have been explicitly included in Guney’s (op. cit.) model.

3.17 In 2012, Adeyele & Yusuff published research on the effect on student performance of the relationship between the student and lecturer at Ahmadu Bello University, Nigeria. This research was therefore done in possibly the most similar socio-economic environment to that present in South Africa. The research was conducted
on 192 students from three departments, however, namely Accounting, Business Administration and Public Administration (Adayele & Yusuff, 2012). As the authors of this paper are interested in professional courses only, the Business Administration and Public Administration dilute the applicability of Adeyele & Yusuff’s (op. cit.) research to actuarial science students.

3.18 Adeyele & Yusuff (op. cit.) included only students who had sat at least four semesters’ examinations in their research. This research would, therefore, exclude first year students sitting for the first time and therefore mitigate some of the noise highlighted by Paisey & Paisey (op. cit.), as discussed in ¶3.8. Including only students who had sat at least four semesters’ examinations does, however, possibly introduce the post-examination bias hypothesised by Naser & Peel (op. cit.), as described in ¶3.6.

3.19 Adeyele & Yusuff (op. cit.) concluded broadly that student performance is positively affected by improving relationships between the student and the lecturer. The authors of this paper point out that the student–lecturer relationship is only one of many tools that contribute towards the value added through teaching.

3.20 In summary, therefore, the academic literature does indicate with some degree of statistical significance that teaching adds value in the context of professional courses. It is therefore suggested that ASSA should ensure that sufficient support is provided to teachers to maximise the value that they add. The research of the authors differs on the exact nature of the value added, but, for the purpose of this paper, the generality of the value added, rather than the specifics, are of greater interest.

4. POOR COURSE MATERIAL DESIGN AS AN ADDITIONAL OBSTACLE TO EFFECTIVE TEACHING IN PROFESSIONAL COURSES

4.1 As defined in ¶1.1, ‘teaching’ encompasses a broad collection of activities associated with the imparting of instruction or knowledge. For the purposes of this section, however, the authors will divorce the course material design from the rest of ‘teaching’.

4.2 The reason for this divorce is rooted in the examination material chosen by the Actuarial Society of South Africa, which has indicated in its 2013 student handbook that the official course materials for the A1 and A2 actuarial subjects are the Institute and Faculty of Actuaries’ core readings. This then becomes the core reference material for actuarial tuition in South Africa, i.e. it may be seen as an externally set compulsory curriculum that teachers are required to cover. As such, an intuitive question that follows is whether or not poorly designed externally set course material poses a significant obstacle to effective teaching.

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6 Actuarial Society of South Africa’s student handbook 2013, 65
4.3 As discussed in ¶3.1, the paucity of relevant actuarial education research forces the authors to research the accounting profession as a reasonable proxy. The focus of this paper on practical investigations again further reduces the amount of relevant literature substantially.

4.4 Even within the reasonable volume of accounting education research, it is difficult to find research discussing poor course material design as an obstacle to effective teaching. The authors therefore investigated this question from the positive perspective, i.e. the elements that teachers look for in a well-designed course material.

4.5 In 2010, Ferguson et al. (2010) published research on accounting teachers’ conception of the use and content of accounting textbooks. The research was limited to teachers of introductory financial accounting in the United Kingdom (Ferguson et al., op. cit.). This research therefore should be most applicable to ASSA’s A1 and A2 level subjects.7

4.6 Part of the research by Ferguson et al. (op. cit.) was conducted through semi-structured interviews with selected teachers. Only eleven teachers were interviewed, however. This very small sample size would ordinarily lead to results that lack credibility. The interviews conducted by Ferguson et al. (op. cit.) were in-depth and lasted between 30 minutes and one hour. This should contribute towards the interviews providing greater insight and therefore would be suitably meaningful for the purposes of this paper.

4.7 Appropriate to the research of this paper, the principal reasons that the teachers provided for choice of accounting textbook were (Ferguson et al., op. cit.):

— well-structured texts and communicable presentation of information;
— alignment between the course material content and teaching of the course; and
— texts written from the perspective of the decision-maker.

The converse argument of this is that if the course material does not sufficiently meet these requirements, the material would pose an additional obstacle to the effective teaching of that course.

4.8 In 2000, Adler, Milne & Stringer published research on accounting teachers’ conceptions on the obstacles to learner centred teaching. The authors randomly surveyed 104 teachers from New Zealand and Australian tertiary institutions (Adler, Milne & Stringer, 2000). Compared with the research done by Ferguson et al. (op. cit.), as discussed in ¶4.6, this appears to be a much more credible study, but the nature of the survey is very different. The research done by Ferguson et al. (op. cit.) involved

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7 Actuarial Society of South Africa’s student handbook 2013, 8
detailed interviews rather than a survey questionnaire and therefore provided depth of response rather than of breadth. No specific student year was targeted and therefore the research should be applicable in generality across ASSA’s A1 and A2 level courses.

4.9 Adler, Milne & Stringer (op. cit.) found that teachers were under constant pressure in each of the technical accounting subjects to cover sufficiently the expansion in “diversity and technical complexity”. As such, they found that (Adler, Milne & Stringer, op. cit.):

[with so many topics to cover, and no room for any leeway on topics to omit, many of the educators were taken aback with the question of whether they would consider introducing more student-led learning activities. These educators saw student-led activities as time consuming and therefore at odds with obtaining maximum topic coverage.

4.10 The profound implications for actuarial science education of this research is that if the course material is expanding to reflect the evolution of the actuarial profession, such as the introduction of subject A205 (Financial Economics), ASSA needs to consider seriously whether the expansion still allows time for effective teaching, i.e. a student-centric approach. If this is not considered, the course material may not sufficiently meet the requirements discussed in ¶4.7, specifically poorly structured texts and non-alignment between course material content and the ability to adequately teach it.

5. EXPOSITION OF RESEARCH

5.1 Outline of the Data

5.1.1 The Actuarial Science programme offered by the University of the Witwatersrand, South Africa, grants its students, through its affiliation to the Actuarial Society of South Africa (ASSA), the opportunity to obtain exemptions from certain ASSA qualifying examinations. There are nine such exemptions on offer within the three-year undergraduate degree, and three within the one-year Honours degree, i.e. twelve in total over four years of study. Exemptions are usually dependent on the final examinations corresponding to particular university courses and, as such, several of these courses are supplemented with a core reading, which is issued by ASSA and relates directly to the corresponding professional subject material. The investigations carried out in this paper are targeted only at those courses for which a core reading is distributed to participating students. The reason for this decision is that ‘value added’ by teachers in teaching specific university courses is readily definable according to students’ relative reliance on lectures and lecture material as compared to the corresponding core reading and any other material issued by ASSA.

8 Actuarial Society of South Africa’s student handbook 2013, 8
9 Actuarial Society of South Africa’s student handbook 2013, 65
5.1.2 Details of the subjects and corresponding university courses that are to be included in the investigations are outlined below:

— Subject A103, Finance and Financial Reporting, is studied over first and second year; exemptions are awarded based on a combined result of the overall course mark for Business Accounting I and the final examination for Business Applications, which forms part of Actuarial Science II; a core reading is distributed to students studying Actuarial Science II.

— Subject A201, Financial Mathematics, is studied over first and second year; exemptions are awarded based on the final examination for Financial Mathematics, which forms part of Actuarial Science II; a core reading is distributed to students studying Actuarial Science II.

— Subject A202, Models, is studied over third year; exemptions are awarded based on a combined result of the Survival Models (which forms part of Actuarial Science III) final examination and the Stochastic Processes (which forms part of Mathematical Statistics III) final examination; a core reading is distributed to students studying Actuarial Science III.

— Subject A203, Contingencies, is studied over second and third year; exemptions are awarded based on the final examination for Life Contingencies, which forms part of Actuarial Science III; a core reading is distributed to students studying Actuarial Science III.

— Subject A204, Statistical Methods, is studied over third year; exemptions are awarded based on a combined result of the Applied Statistical Modelling mid-year and end-year examinations and the Risk Theory final examination; both courses form part of Mathematical Statistics III; a core reading is distributed to students studying Mathematical Statistics III.

— Subject A205, Financial Economics, is studied over third year; exemptions are awarded based on the final examination for Actuarial Economics, which forms part of Actuarial Science III; a core reading is distributed to students studying Actuarial Science III.

— Subject A301, Actuarial Risk Management, is studied over fourth year; exemptions are awarded based on the final examination for the Actuarial Science Honours first semester course; a full reading is distributed to students studying Actuarial Science Honours.

5.1.3 Note that in addition to the list in §5.1.2, exemptions are also offered for various other subjects, which have been omitted from the investigations because either no core reading is distributed to participating students of those courses as explained in §5.1.1, or that, at the time of the investigations, no students had studied or were studying the relevant courses. Also note that the distinction between ‘full reading’ as mentioned in terms of subject A301 (Actuarial Risk Management) below

5.3.17.3, and ‘core reading’ is deemed to be immaterial for the purposes of this paper.

5.1.4 Exemptions are awarded to students who achieve in excess of a specific percentage score benchmark in certain prescribed university examinations. This benchmark is decided by an external examiner appointed on behalf of ASSA. Note that merely passing one of these prescribed examinations does not necessarily qualify a student for exemption from the corresponding ASSA examination.

5.1.5 To examine ‘value added’ by teachers as it is conceived by students in the context set out above, a survey questionnaire was distributed to participating students of the various relevant university courses, and the responses recorded. The extract taken from the survey questionnaire, shown in full in Appendix A, forms the basis for the investigations demonstrated in this section.

5.1.6 Second year students submitted responses to the survey questions outlined in Appendix A for each of the following subjects:
- A103 (Finance and Financial Reporting); and
- A201 (Financial Mathematics).

5.1.7 Third year students submitted responses to the survey questions outlined in Appendix A for each of the following subjects:
- A103 (Finance and Financial Reporting)*;
- A201 (Financial Mathematics)*;
- A202 (Models);
- A203 (Contingencies);
- A204 (Statistical Method); and
- A205 (Financial Economics).

5.1.8 Fourth year students submitted responses to the survey questions outlined in Appendix A for each of the following subjects:
- A103 (Finance and Financial Reporting)*;
- A201 (Financial Mathematics)*;
- A202 (Models)*;
- A203 (Contingencies)*;
- A204 (Statistical Method)*;
- A205 (Financial Economics)*; and
- A301 (Actuarial Risk Management).

5.1.9 Note, however, that at the time of dispensing the survey questionnaire, certain student groups had not yet completed specific courses referred to in ¶¶5.1.6–8 and, as such, non-repeating students had not yet attempted the relevant university examinations. Subjects marked with an asterisk (*) in ¶¶5.1.6–8 are those for which the applicable student group had completed the corresponding university course and therefore had sat the relevant examinations at the time of responding to the survey.
questionnaire outlined in Appendix A. This is a particularly pertinent distinction given the discussion outlined in ¶3.6. For completeness, an extract of the responses to the survey questionnaire by second year students for subject A103 (Finance and Financial Reporting) is shown in Appendix B. The responses related to other student groups and for other subjects are similarly captured.

5.2 Survey Considerations

5.2.1 Introduction

5.2.1.1 Ideally, the research would report on the findings of a pure longitudinal survey. In a longitudinal survey, “the same group of subjects (individuals) is followed during each wave [of surveys, which allows researchers] to focus on changes occurring within subjects and to make population inferences that are not as sensitive to between-subject variation”.

The nature of the survey distributed by the authors, given the population sample, does allow for this pure longitudinal form to emerge, but only until this survey is processed over a few years, particularly tracking the current second year students into Honours.

5.2.1.2 The current research, however, is a different form of a longitudinal survey that asks students about their conceptions of the value added by teaching over years of study. The nature of this survey results in a number of potential concerns that the authors recognise and have attempted to mitigate.

5.2.1.3 In 2005, Van der Stede, Young & Chen researched empirical management accounting surveys from 1982 to 2001 to deduce common survey problems. The main strength of their research was using a survey framework that “has been used previously by judges to determine the efficacy of surveys offered as evidence in court” (Van der Stede, Young & Chen, 2005); this means that there is a solid legal verification of the framework. Their template has therefore been used to consider similar aspects with regard to the longitudinal survey conducted for this paper.

5.2.2 Recall Bias

5.2.2.1 This problem refers to how respondents’ conceptions of a phenomenon change with duration from the date of the phenomenon. Such bias may be evidenced in the survey questionnaire used, as explained below in ¶5.3.16.3.

5.2.2.2 It is very difficult to mitigate this bias, but the authors remain cognisant of its presence and comment where appropriate, e.g. ¶5.3.16.3.

5.2.3 Survey Population

5.2.3.1 Van der Stede, Young & Chen (op. cit.) pointed out that “if the survey population includes subjects not in the target population..., or omits subjects in the target population..., then the study will yield biased results”.

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5.2.3.2 The total population for the purposes of this research is the total of the second, third, and fourth year population of actuarial science students attending the University of the Witwatersrand in 2013. The authors have tried to mitigate the survey population problem by attempting to survey each actuarial science student in situations where attendance is compulsory, e.g. tests and tutorials. Thus the main sample selection issues are avoided.

5.2.4 Sample Size

5.2.4.1 Van der Stede, Young & Chen (op. cit.) indicated that “minimum samples of 200–300 respondents seem to be able to achieve a certain degree of face validation in court”.

5.2.4.2 The authors sampled a total of 195 students, which falls just below the minimum threshold of 200, which therefore would ordinarily reduce the credibility that may be attached to any conclusions. This has been mitigated, however, by attempting to survey the total population and thereby ensuring that there is very little deviation of the sample from the population as discussed in ¶¶5.2.3.

5.2.4.3 Once a few years of data is collected and a pure longitudinal survey is able to be performed, the data would easily meet and surpass the sample size threshold as proposed by Van der Stede, Young & Chen (op. cit.) mentioned in ¶¶5.2.4.1

5.2.4.4 The main sampling problems are covered in ¶¶5.2.3–4. Van der Stede, Young & Chen (op. cit.) pointed out, however, that:

“[n]on-sampling error is no less important than sampling error. In fact, non-sampling error has been shown to be the most severe contributor to total survey error.”

There are two elements of non-sampling error that the authors will briefly discuss, namely response and non-response errors.

5.2.5 Response Error

5.2.5.1 “[R]esponse error… occurs when some actual respondents respond inaccurately” (Van der Stede, Young & Chen, op. cit.). The primary driver of response errors is a poorly designed survey questionnaire which might (Van der Stede, Young & Chen, op. cit.):

— systematically distort… responses;
— inflate random error if respondents make guesses because they do not understand the question; and/or
— include subjective bias in the question setting.

5.2.5.2 The authors attempted to reduce response errors by pre-testing the survey questionnaire with colleagues, who were also the primary users of the data. Changes were then made to cater for the feedback that was deemed material. This may only partially mitigate the subjective bias, however, as the pre-tested colleagues are
also teachers and may therefore suffer from the same subjective perspective mentioned above in ¶5.2.5.1.

5.2.5.3 The authors did not, however, pre-test the survey questionnaire with a sample of the student responses. This may be a critical fault in the survey design, as it needs to be ensured that students are able to understand the questions. An attempt at mitigating this risk of response error was made through asking two similar questions on the value added through teaching and checking for corroboration, as discussed later in ¶5.3.5.

5.2.5.4 One of the authors also attended a survey questionnaire workshop for the third and fourth year student groups and noted that very few queries were raised regarding the questions. Although this is merely anecdotal, it does provide some comfort with regard to the design of the survey questionnaire.

5.2.6 Non-Response Error

5.2.6.1 “[N]on-response error… occurs when some target respondents do not reply, causing responses to be an unreliable representation of the selected sample” (Van der Stede, Young & Chen, op. cit.).

5.2.6.2 Diamond\(^\text{12}\) postulated that:

One … formula for quantifying a tolerable level of non-response in a probability sample is based on the guidelines for statistical surveys issued by the former U.S. Office of Statistical Standards. According to these guidelines, response rates of 90% or more are reliable and generally can be treated as random samples of the overall population. Response rates between 75% and 90% usually yield reliable results, but the researcher should conduct some check on the representativeness of the sample.

5.2.6.3 The lowest response rate obtained is 81% for question three posed to the third year student group for subject A205 (Financial Economics), refer to Table 1. Therefore the results are deemed reliable. An additional source of bias may then become present, however.

5.2.6.4 This additional potential source of bias reflects the “extent to which respondents are systematically different from non-respondents” (Van der Stede, Young & Chen, op. cit.). An extreme example of this bias in this research exposition would be if the group of non-respondents reflect the students who do not conceive the value added through teaching, the remaining respondents would effectively be a self-selected group that is more likely to conceive the value added through teaching. This is potentially a valid concern with regard to the research performed.

5.2.6.5 The authors have attempted to mitigate this additional source of bias through clearly affirming to the students that the responses are anonymous. Students may voluntarily indicate their student number in their response, but this was not a

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compulsory requirement and was not used in carrying out the research. In addition, if the non-response is as a result of general apathy towards education-related research then there would not be a selective difference between respondents and non-respondents. Moreover, the reasonably high response rate, consistently greater than 80%, does reduce the effect of this bias.

5.3 Analysis of ‘Conceived Value’

5.3.1 For the sake of clarity, the authors define two related types of teacher ‘added value’. The first, which is investigated in this section, relates purely to the conceptions of students with regard to the teacher adding value in the context of each university course, independent of those students’ performance in subsequent examinations. Hence, this first type of ‘value’ is termed ‘conceived value’. The second, which is investigated below in ¶5.4, relates the conceptions of students with regard to the value added through teaching to those students’ performance in subsequent examinations, and, as such, is termed ‘validated value’.

5.3.2 To investigate ‘conceived value’, as it is defined in ¶¶5.3.1 above, student responses to survey questions three and four are used as proxies of an indication of the value being added by teachers with respect to the relevant corresponding courses. The questions, as specified for subject A103 (Finance and Financial Reporting), for example, also shown in Appendix A, are given below for ease of reference:

3) For A103 (Finance and Financial Reporting), how helpful was the Core Reading (the material provided by the Institute and Faculty of Actuaries) in preparing for the exam?
   a) Relied solely on the core reading
   b) Relied mainly on the core reading
   c) Fair split between the core reading and lectures and lecture material
   d) Relied mainly on lectures and lecture material
   e) Relied solely on lectures and lecture material

4) For A103 (Finance and Financial Reporting), how confident would you be in sitting the exam without any lecture support (including tutorials and consultations)?
   a) Not confident at all
   b) Slightly confident
   c) Fairly confident
   d) Reasonably confident
   e) Extremely confident

5.3.3 Note that the responses to survey question four are taken to be a better proxy for the value added by teachers than the responses to survey question three. This is because, due to its particular phrasing, survey question three may provide an indication other than solely that of teacher ‘added value’. It may be the case that student responses to survey question three are distorted by the structure of the professional
subject material. This idea is illustrated in the context of one of the aforementioned subjects listed in ¶¶5.1.2, namely subject A204 (Statistical Methods).

5.3.4 For subject A204 (Statistical Methods), the corresponding university course is subject to a lesser degree of oversight by actuaries within the Statistics and Actuarial Science department, i.e. those members of staff with greater cognisance of subject-specific professional core reading material. Hence, students selecting either options D or E to survey question three for subject A204 (Statistical Methods) may indicate that the teacher of the corresponding course is presenting learning material beyond the core reading material. That is, for subject A204 (Statistical Methods), the core reading provides less content than would be examinable by the university, and hence survey question three provides less of an indication of the ‘value added’ by the teacher, as defined in the context of the relative use by students of corresponding core reading material.

5.3.5 Note that for subject A204 (Statistical Methods) mentioned in ¶¶5.3.3–4, survey question three is likely to be a relatively unsuitable proxy for teacher added value as compared with survey question four. This is a function of the premise that survey question four attempts to ascertain ‘conceived value’ at a more focused level than survey question three, which is subject to varying interpretations. That is, there is less opportunity for spurious findings within the responses to survey question four as compared to survey question three. As such, in those cases for which the results derived from survey questions three and four are contradictory, the results derived from survey question four are favoured. When the findings based on both survey question three and four are in alignment, however, this is taken to be a more credible confirmation regarding the teaching ‘value added’ according to the results. This also mitigates some of the response bias discussed in ¶5.2.5.

5.3.6 The responses to survey questions three and four are used to test the following hypotheses:

H₀: Students conceive that teacher added value is negligible

H₁: Students conceive that teacher added value is significant

5.3.7 The following methodology is explained with reference to survey question three, but is similarly applicable to survey question four. It is assumed that, under the null hypothesis, responses by students are randomly, and hence evenly, distributed across the five question options. This is consistent with students, on average, conceiving that no significant value is being added by the teacher. Therefore, defining \( p_i \) to be the proportion of overall responses of option \( i \), for \( i \in \{A, B, C, D, E\} \), for survey question three, it can be assumed that, under the null hypothesis, \( p_A = p_B = p_C = p_D = p_E = 0.2 \), such that the sum of the \( p_i \) equates to one.

5.3.8 It is then assumed that students’ responses to survey question three being either option D (“relied mainly on lectures and lecture material”) or option E (“relied solely on lectures and lecture material”) is indicative of there being value added by the teacher. Therefore, defining \( p = p_D + p_E \), the above hypotheses defined in ¶¶5.3.6 can be restated as:
\[ H_0: \, p = 0.4 \]
\[ H_1: \, p > 0.4 \]

This allows a one-sided binomial test to be performed with respect to testing the above hypotheses related to the responses by students to survey question three for the various included subjects outlined in \(\text{¶5.1.2.}\) Note that by grouping the responses into two groups, the assumed distribution of responses under the null hypothesis, as discussed in \(\text{¶5.3.7.}\), can be relaxed. As long as the underlying distribution is elliptical – which may reflect a natural inclination of respondents to less extreme questionnaire statements – then the test outlined above will be more stringent, since the effective rejection proportion would be smaller than 0.4.

5.3.9 The tests are performed in various forms of detail, starting with the total of students from all years for all subjects, eventually broken down into students by year of study and by subject-specific responses. In Table 1 shown below, \(x\) refers the observed number of responses out of the overall sample size, \(n\), corresponding to options D or E. For example, \(x = 32\) of the \(n = 74\) responses to survey question three for subject A103 (Finance and Financial Reporting) from third year students correspond to options D or E (see Table 1).

5.3.10 From the information described above in \(\text{¶5.3.9.}\), a test statistic is calculated, given as follows:

\[
\text{Test Statistic} = \frac{x - p}{\sqrt{np(1-p)}} = \frac{x - 0.4}{\sqrt{0.24/n}}
\]

Under the null hypothesis, the above test statistic is a realisation of a random variable which has an approximate standard normal distribution. A normal approximation to the binomial distribution is used, as the approximation criteria proposed by Byrkit (1987) and Roscoe (1975), which is that \(np(1-p) \geq 5\), is satisfied for each sample tested.

5.3.11 A possible limitation of using the binomial test in the case of grouping students’ responses across different subjects for the same year of study (e.g. aggregate of all third year responses across the different subjects) is that the underlying assumption that individual responses are independent is not satisfied. This is the case since the above aggregation combines the responses of the same group of students across different courses, and hence certain responses will exhibit non-independence as they would be derived from the same student. Since the various actuarial science courses are taught independently of each other, however, the authors believe that the effect of this non-independence is negligible, and that the rationale of the binomial test still applies.

5.3.12 Note that the authors assert that the above formulation of hypotheses testing in \(\text{¶5.3.6–10.}\) is a more robust and rigorous testing procedure as compared to those carried out by Guney (op. cit.), Paisey & Paisey (op. cit.) and Naser & Peel.
This is the case since testing for significance in teacher ‘added value’ as indicated by each survey question in isolation is inherently parsimonious, which is a concept described by Thurstone (1947) as “finding the smallest number of parameters for describing each test”. This advantage of simplicity informs the robustness of the hypotheses testing performed. There is also a further advantage of flexibility, which additionally informs the rigor of the hypotheses testing performed.

<table>
<thead>
<tr>
<th>Student Group</th>
<th>Subject</th>
<th>n</th>
<th>x</th>
<th>Test Statistic</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
<td>815</td>
<td>379</td>
<td>3.789 583</td>
<td>*** **</td>
</tr>
<tr>
<td>Total</td>
<td>A103</td>
<td>195</td>
<td>65</td>
<td>(1.900 292)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>193</td>
<td>107</td>
<td>4.378 567</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>102</td>
<td>51</td>
<td>2.061 553</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>101</td>
<td>54</td>
<td>2.762 311</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>97</td>
<td>75</td>
<td>7.502 691</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>95</td>
<td>25</td>
<td>(2.722 550)</td>
<td></td>
</tr>
<tr>
<td>2nd year</td>
<td>Total</td>
<td>170</td>
<td>45</td>
<td>(3.600 790)</td>
<td>*** **</td>
</tr>
<tr>
<td>3rd year</td>
<td>405</td>
<td>232</td>
<td></td>
<td>7.100 107</td>
<td>***</td>
</tr>
<tr>
<td>4th year</td>
<td>240</td>
<td>102</td>
<td></td>
<td>0.790 569</td>
<td>***</td>
</tr>
<tr>
<td>2nd year</td>
<td>A103</td>
<td>85</td>
<td>12</td>
<td>(4.870 882)</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>85</td>
<td>33</td>
<td>(0.221 404)</td>
<td></td>
</tr>
<tr>
<td>3rd year</td>
<td>A103</td>
<td>74</td>
<td>32</td>
<td>0.569 495</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>73</td>
<td>52</td>
<td>5.447 131</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>67</td>
<td>40</td>
<td>3.291 781</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>68</td>
<td>39</td>
<td>2.920 935</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>63</td>
<td>50</td>
<td>6.377 872</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>60</td>
<td>19</td>
<td>(1.317 616)</td>
<td></td>
</tr>
<tr>
<td>4th year</td>
<td>A103</td>
<td>35</td>
<td>21</td>
<td>2.415 229</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>35</td>
<td>22</td>
<td>2.760 262</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>35</td>
<td>11</td>
<td>(1.035 098)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>33</td>
<td>15</td>
<td>0.639 602</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>34</td>
<td>25</td>
<td>3.990 798</td>
<td>*** **</td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>35</td>
<td>6</td>
<td>(2.760 262)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A301</td>
<td>33</td>
<td>2</td>
<td>(3.979 747)</td>
<td></td>
</tr>
</tbody>
</table>

Where:

- *** *** indicates significance at a level of 0.1%
- *** ** indicates significance at a level of 1%
- ** indicates significance at a level of 5%
- *** indicates significance at a level of 0.5%
- *** indicates significance at a level of 2.5%
- * indicates significance at a level of 10%
That is, the value of the parameter $p$ in the hypotheses tests defined in ¶5.3.8 and below in ¶5.3.13 is subject to being capable of a variety of different definitions, which, as illustrated in ¶5.3.8 and below in ¶5.3.13, is useful for deriving suitable hypotheses tests for unique data. It is of the opinion of the authors that, in addition to the above advantages, the applied method of hypotheses testing reduces any tendency towards spurious accuracy and false confidence in the results that is possibly more present within those investigations for which more sophisticated modelling procedures are pursued, particularly regression analyses with relatively small data samples.

5.3.13 A similar framework is set out for the responses to survey question four, except that it is assumed that students’ responses to survey question four being either option A (“not confident at all”) or option B (“slightly confident”) is indicative of there being value added by the teacher. Therefore, the alternative formulation outlined in ¶¶5.3.8 of the hypotheses to be tested applies similarly to survey question four, except that $p = p_A + p_B$, with all other details identical to that outlined in ¶¶5.3.6–10. The results corresponding to the responses to survey question three are shown in Table 1. The results corresponding to the responses to survey question four are shown in Table 2.

5.3.14 **Value added through Teaching with Regard to Actuarial Science in General**

To comment on the objective of the first research question stated in ¶1.3, the results corresponding to the total of students in all years across all subjects illustrated in tables 1 and 2 are of interest. Note that the comment related to non-independence of observations as stated in ¶¶5.3.11 applies here. According to both survey question three (Table 1) and survey question four (Table 2), the null hypothesis is rejected at the most significant level of confidence. It can be concluded that students conceive that teacher added value is significant with regard to actuarial science overall, aggregated across all student years and subjects investigated.

5.3.15 **Value added through Teaching differing By Actuarial Science Subject**

5.3.15.1 To comment on the objective of the second research question stated in ¶1.3, the results corresponding to the total of each subject across all years of study illustrated in tables 1 and 2 are of interest. According to survey question three (Table 1), teachers are found to add no significant value to students with regard to subject A103 (Finance and Financial Reporting) and subject A205 (Financial Economics), whereas teachers are found to add value to students with regard to the remaining subjects at various levels of significance. According to survey question four (Table 2), teachers are found to add value to students with regard to all subjects at the most significant level of confidence, with the exception of subject A205 (Financial Economics), for which the null hypothesis is rejected only at a lower significance level (0.5%).

5.3.15.2 For subject A205 (Financial Economics), the above results should not be interpreted solely as teaching adding negligible value. A potential problem arises of
a different nature to that described in ¶5.3.4–5 for subject A204 (Statistical Methods), as the university course is subject to a greater degree of oversight by actuaries within the School of Statistics and Actuarial Science. Here, students selecting either options A or B to survey question three for subject A205 (Financial Economics) may not be necessarily indicating an ineffective teacher, but rather be indicating a less than adequately structured core reading, which poses an additional hurdle to the teacher in

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**Table 2 Results of the hypotheses tests of conceived teacher added value for survey question four**

<table>
<thead>
<tr>
<th>Student Group</th>
<th>Subject</th>
<th>n</th>
<th>x</th>
<th>Test Statistic</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
<td>825</td>
<td>497</td>
<td>11.868 173</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A103</td>
<td>193</td>
<td>100</td>
<td>3.350 044</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>193</td>
<td>127</td>
<td>7.317 202</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>105</td>
<td>62</td>
<td>3.984 095</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>104</td>
<td>61</td>
<td>3.883 108</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>100</td>
<td>66</td>
<td>5.307 228</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>97</td>
<td>53</td>
<td>2.943 045</td>
<td>*** ***</td>
</tr>
<tr>
<td>2nd year</td>
<td>Total</td>
<td>171</td>
<td>120</td>
<td>8.054 638</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A103</td>
<td>85</td>
<td>51</td>
<td>3.763 863</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>86</td>
<td>69</td>
<td>7.615 900</td>
<td>*** ***</td>
</tr>
<tr>
<td>3rd year</td>
<td>A103</td>
<td>73</td>
<td>38</td>
<td>2.102 401</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>72</td>
<td>46</td>
<td>4.137 677</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>79</td>
<td>49</td>
<td>3.996 042</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>70</td>
<td>46</td>
<td>4.391 550</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>66</td>
<td>52</td>
<td>6.432 242</td>
<td>*** ***</td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>62</td>
<td>44</td>
<td>4.997 368</td>
<td>*** ***</td>
</tr>
<tr>
<td>4th year</td>
<td>A103</td>
<td>35</td>
<td>11</td>
<td>(1.035 098)</td>
<td></td>
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<td></td>
<td>A201</td>
<td>35</td>
<td>12</td>
<td>(0.690 066)</td>
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</tr>
<tr>
<td></td>
<td>A202</td>
<td>35</td>
<td>13</td>
<td>(0.345 033)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>34</td>
<td>15</td>
<td>0.490 098</td>
<td></td>
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<tr>
<td></td>
<td>A204</td>
<td>34</td>
<td>14</td>
<td>0.140 028</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>35</td>
<td>9</td>
<td>(1.725 164)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A301</td>
<td>33</td>
<td>28</td>
<td>5.258 951</td>
<td>*** ***</td>
</tr>
</tbody>
</table>

Where:

*** *** indicates significance at a level of 0.1%
*** * indicates significance at a level of 1%
**  indicates significance at a level of 5%

*** ** indicates significance at a level of 0.5%
***  indicates significance at a level of 2.5%
*    indicates significance at a level of 10%
translating the material to students, as mentioned in ¶4.7–10. This may then encourage
the teacher to restructure the course to better meet the syllabus objectives as compared
with the core reading material, hence distorting the meaning of any results that can
be drawn from the responses by students to survey question three for this subject.
This does, however, need to be investigated further and in greater depth, as the above
commentary is anecdotal derived from lecturers’ experiences and students’ feedback.

5.3.15.3 In accordance with the discussion outlined in ¶¶5.3.3–5, it is concluded
that teachers add significant value to students for all of the subjects investigated.
The contradictory results for subject A103 (Finance and Financial Reporting) may
provide an important insight into how the nature of the underlying course affects the
value that students are able to derive from the teacher. With the exception of subject
A103 (Finance and Financial Reporting), all of the above investigated subjects listed
in ¶¶5.1.2, but excluding subject A301 (Actuarial Risk Management), are technical
in nature. This is an important distinction, as it may be the case that the approach
taken by students with regard to subject A103 (Finance and Financial Reporting) is
fundamentally different to that for other subjects and that any comparisons made in
this investigation may be a function of this feature, rather than of teacher added value
alone. This is plausible since it is expected that students are typically uncomfortable
with the applications-based nature of the material presented in subject A103 (Finance
and Financial Reporting) due to the way in which it contrasts with other subjects. This
needs to be investigated further and in greater depth.

5.3.16 Value added through Teaching differing by Student Cohort Year
5.3.16.1 To comment on the objective of the third research question stated in
¶1.3, the results corresponding to the total of each year of study across all relevant
subjects illustrated in tables 1 and 2 are of interest. Note that the comment related
to non-independence of observations as stated in ¶¶5.3.11 applies here. For second
year students, the teacher added value is negligible with reference to survey question
three (Table 1), whereas it is strongly significant with reference to survey question four
(Table 2). Since second year students submit responses to only two of the seven subjects
investigated, these results may be based more on the subject-specific conceptions than
on a cohort effect. This may be the case since approximately half of the overall responses
for second year students relate to subject A103 (Finance and Financial Reporting),
which, as has already been discussed in ¶¶5.3.15.3, differs in nature from the other
subjects and hence may not exhibit easily relatable characteristics with regard to an
investigation of teacher added value.

5.3.16.2 Third year students are observed to conceive that teacher added value
is strongly significant with reference to both survey question three (Table 1) and
survey question four (Table 2). These results do not appear to exhibit the same extent
of dependence on the subject-specific conceptions as compared to the second year
students since responses from a greater range (six) of more homogeneous subjects are
being aggregated.
5.3.16.3 For fourth year students, the results from both survey question three (Table 1) and survey question four (Table 2) indicate that teacher added value is negligible. This is an unexpected finding for which no clearly explicable cause is apparent, other than that the value added by teaching is truly negligible given hindsight. A possible different explanation, however, follows from Paisey & Paisey (op. cit.), who surmise that Honours level students, who are naturally a self-selected group by meeting stringent Honours entrance requirements, probably have greater work ethic and motivation as compared to undergraduate students, as discussed in ¶3.8. This may lead to a class of students who collectively spend a greater proportion of time working on their own than purely in lectures as compared to undergraduate students. As an additional alternative explanation, the lack of conceived value from the fourth year student group may also be due to the presence of some form of hindsight bias. This may further be exaggerated due to the changed nature of the course taught in fourth year, A301 (Actuarial Risk Management), which, like subject A103 (Finance and Financial Reporting), is applications-based and requires the development of a different skill-set by participating students. This could lead to a sense that previously studied courses are ‘easy’ in comparison. Note that these suggested explanations are not necessarily mutually exclusive.

5.3.16.4 There is also the presence of survivorship bias within the fourth year student group, as only those students that have obtained a minimum of four exemptions from previously studied subjects are allowed entrance into the University of the Witwatersrand actuarial science Honours programme. This is exaggerated since Honours students are accepted based on voluntary application. This should be considered in relation to the results derived from this investigation. Although this survivorship bias is present in all years of study following first year, it is most significant in the fourth year student group due to the increased rate of drop-outs between third and fourth year as compared to other years of study.

5.3.16.5 Note that a cohort effect may be externally imposed on the findings in those cases for which the member of academic staff teaching a specific course changes between different student groups. The authors, however, believe that this is not the primary driver of any cohort effect observed.

5.3.17 Value added through Teaching differing by Student Cohort Year and Actuarial Science Subject

5.3.17.1 To comment on the objective of the fourth research question stated in ¶1.3, the results corresponding to the subject-specific responses for each year of study illustrated in tables 1 and 2 are of interest. Note that these results are merely contributory to those outlined in ¶¶5.3.14–16, and as such are not discussed in great detail. For second year, the teacher added value is negligible for each subject according to survey question three (Table 1), whereas according to survey question four (Table 2), the teacher added value is strongly significant for each subject. This, as already discussed in ¶¶5.3.3–5, is taken to suggest that teachers add significant
value in these courses as conceived by second year students, given that survey question four is preferred to survey question three in ascertaining whether teaching adds value.

5.3.17.2 Third years students have indicated that they conceive significant value being added by teachers for subjects A201 (Financial Mathematics), A202 (Models), A203 (Contingencies) and A204 (Statistical Methods), as confirmed by the congruence of the responses to survey questions three (Table 1) and four (Table 4). There is no such congruence for subjects A103 (Finance and Financial Reporting) and A205 (Financial Economics), however, for which survey question three (Table 1) indicates negligible value added by teachers and survey question four (Table 2) indicates significant value added (2.5% significance level for subject A103 and 0.1% significance level for subject A205). Both of these subjects have been discussed above in ¶¶5.3.15.3 and ¶¶5.3.15.2, respectively.

5.3.17.3 The fourth year student group responses for subjects A202 (Models) and A203 (Contingencies), as compared to the third year student group responses for these subjects, may indicate the incidence of the externally imposed cohort effect mentioned in ¶¶5.3.16.5. The responses by fourth year students relating to subject A301 (Actuarial Risk Management) are interesting. According to survey question three (Table 1), students rely predominantly on the full reading material, whereas according to survey question four (Table 2), these same students conceive strongly significant teacher added value. This is likely because subject A301 (Actuarial Risk Management) is the only subject for which the corresponding university course material is in fact the ASSA material itself, in this case, the full reading. The full reading is both large in volume, resulting in fewer expansion opportunities for teachers, and attempts to better explain the core principles, as indicated by The Actuarial Education Company in stating that “the [full reading] Course Notes incorporate the complete Core Reading and include full explanation of all the syllabus objectives, worked examples and short questions to test [students’] understanding”. Hence, the authors believe that these contradictory responses to survey question three (Table 1) and survey question four (Table 2) for subject A301 (Actuarial Risk Management) are the direct result of the way in which the course material is structured.

5.4 Analysis of ‘Validated Value’

5.4.1 The analyses outlined in ¶5.3 relate to teacher added value as it is conceived by students. A natural extension of this is to investigate some standard objective of ‘value added’.

5.4.2 For each combination of student year and subject, responses based on survey questions three and four are divided into two distinct samples:

those responses indicating that teacher added value is conceived to be significant (that is, options D or E for survey question three, and options A or B for survey question four); and
— those responses indicating that lecturer added value is negligible (that is, options A or B for survey question three, and options D or E for survey question four).

Note that option C for either survey question three or survey question four is taken to indicate that teacher added value is conceived to be neither significant nor negligible.

5.4.3 It is of interest to investigate whether the exemption rates for the student group that conceives teacher added value to be significant is significantly greater than the exemption rates for the student group that conceives teacher added value to be negligible. If so, this is taken as evidence of ‘validated value’.

5.4.4 Note that the responses of students who are repeating certain university courses as a result of failing the corresponding year of study are omitted from this investigation as it is intended to remove any heterogeneity within the response data. As such, the investigation is carried out for first time writers only, as is indicated by survey question two. Survey questions one and two, as specified for subject A103 (Finance and Financial Reporting), for example, also shown in Appendix A, are given below for ease of reference:

1) Do you have the exemption for A103 (Finance and Financial Reporting)?
   a) Yes
   b) No
2) How many times have you sat an exam for A103 (Finance and Financial Reporting)?
   a) 0
   b) 1
   c) 2
   d) 3
   e) More than 3

5.4.5 The responses to survey questions three and four, in combination with the responses to survey questions one and two, are used to test the following hypotheses:

- $H_0$: Students who recognise that value is being added by teachers are no more likely to obtain exemptions from corresponding subject examinations than those students who do not
- $H_1$: Students who recognise that value is being added by teachers are more likely to obtain exemptions from corresponding subject examinations than those students who do not

5.4.6 The following methodology is explained with reference to survey question three, but is similarly applicable to survey question four. Under the null hypothesis, the proportion of students obtaining exemptions within the student group related to
responses D or E—those students conceiving that teacher added value is significant—should be approximately the same as the proportion of the students obtaining exemptions within the student group related to responses A or B—those students conceiving that teacher added value is negligible. Under the alternate hypothesis, however, the proportion of students obtaining exemptions within the former student group should be significantly greater than the proportion of students obtaining exemptions within the latter student group. Therefore, defining $p_1$ to be the proportion of students who obtained exemption from a relevant subject examination within the overall student group related to responses D or E, and defining $p_2$ similarly for the overall student group related to responses A or B, the hypotheses stated in ¶¶5.4.5 can be restated as:

$$H_0: p_1 = p_2$$

$$H_1: p_1 > p_2$$

This allows one-sided binomial testing of a difference of proportions as specified in the above hypotheses for the various included subjects listed in ¶¶5.1.2.

5.4.7 In Table 3, $x_1$ refers the observed number of exemptions obtained by students within $n_1$, the overall student group of first-time writers conceiving that teacher added value is significant. Similarly, $x_2$ refers to the observed number of exemptions obtained by students within $n_2$, the overall student group of first-time writers conceiving that teacher added value is negligible. For example, $x_1 = 25$ exemptions were obtained by third year students for subject A103 (Finance and Financial Reporting) out of a sample of $n_1 = 30$ students who conceive that lecturer added value is significant, whereas $x_2 = 13$ exemptions were obtained out of a sample of $n_2 = 18$ students from the same student group for the same subject, but who conceive that lecturer added value is negligent (see Table 3).

5.4.8 From the information described above in ¶¶5.4.7, a test statistic is calculated, given as follows:

$$Test\ Statistic = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1 - \hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Where:

$$\hat{p}_1 = \frac{x_1}{n_1}$$

$$\hat{p}_2 = \frac{x_2}{n_2}$$

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2}$$
Under the null hypothesis, the above test statistic is a realisation of a random variable which has an approximate standard normal distribution. This is argued similarly to that for §5.3.10, however, since the sample sizes tested are significantly smaller than those evaluated in §5.3, the proceeding results given in Table 3 and Table 4 are less credible. Unfortunately, combining samples from two independent binomial distributions may not result in a usable aggregate binomial distribution for hypotheses testing, and so a normal approximation is used instead.

5.4.9 A similar framework is set out for the student groups divided according to survey question four as per the description outlined in §§5.4.2. The results corresponding to the responses to survey question three are shown in Table 3 and the results corresponding to the responses to survey question four are shown in Table 4. Note that responses by second year students do not feature in these tables as no relevant examinations had been sat by second year students at the time of dispensing the survey questionnaire. Note also that the bias mentioned in §3.6 relating to post-examination responses by students, as highlighted by Naser & Peel (op. cit.), is present in this investigation.

5.4.10 **Student Exemption Rates differing by Conceived Value of Teaching**

5.4.10.1 For subject A201 (Financial Mathematics), the null hypothesis, as stated in §§5.4.6, is rejected for both survey question three (Table 3) and survey question four (Table 4) across all student years at a significance level of 2.5%. For the third year student group, the null hypothesis, as stated in §§5.4.6, is rejected for subject A201 (Financial Mathematics) at a 5% significance level for both survey question three (Table 3) and survey question four (Table 4). For the fourth year student group, the null hypothesis, as stated in §§5.4.6, is rejected for subject A201 (Financial Mathematics) only for survey question four (Table 4) at a significance level of 2.5%. The rejection of the null hypothesis, as stated in §§5.4.6, at the 10% significance level for subject A103 (Finance and Financial Mathematics) and subject A203 (Contingencies) according to tables 3 and 4, respectively, is ignored by the authors due to the lack of congruence in the results of the survey questions. Therefore, subject A201 (Financial Mathematics) serves as the only confirmable rejection of the null hypothesis to be drawn from the above tables.

5.4.10.2 It is worth noting in the above tables the negative values for the test statistic calculated for certain combinations of student year and subject, shown as follows:

— total of all subjects across all years of study (Table 3 only);
— subject A103 across all years of study (Table 4 only);
— third year student group across all subjects (Table 4 only);
— fourth year student group across all subjects (Table 3 only);
— subject A103 for the third year student group (Table 4 only);
— subject A103 for the fourth year student group (Table 4 only);
Table 3 Results of the hypotheses tests of validated teacher added value for survey question three

<table>
<thead>
<tr>
<th>Student Group</th>
<th>Subject</th>
<th>$n_1$</th>
<th>$x_1$</th>
<th>$n_2$</th>
<th>$x_2$</th>
<th>Test Statistic</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
<td>163</td>
<td>100</td>
<td>58</td>
<td>36</td>
<td>(0.096 7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>A103</td>
<td>50</td>
<td>44</td>
<td>25</td>
<td>19</td>
<td>1.336 3</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>61</td>
<td>28</td>
<td>6</td>
<td>0</td>
<td>2.175 2</td>
<td>***</td>
</tr>
<tr>
<td>3rd year</td>
<td>Total</td>
<td>73</td>
<td>45</td>
<td>22</td>
<td>13</td>
<td>0.215 3</td>
<td></td>
</tr>
<tr>
<td>4th year</td>
<td>Total</td>
<td>90</td>
<td>55</td>
<td>36</td>
<td>23</td>
<td>(0.290 1)</td>
<td></td>
</tr>
<tr>
<td>3rd year</td>
<td>A103</td>
<td>30</td>
<td>25</td>
<td>18</td>
<td>13</td>
<td>0.917 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>43</td>
<td>20</td>
<td>4</td>
<td>0</td>
<td>1.799 6</td>
<td>**</td>
</tr>
<tr>
<td>4th year</td>
<td>A103</td>
<td>20</td>
<td>19</td>
<td>7</td>
<td>6</td>
<td>0.807 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>18</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>1.217 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>9</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>0.430 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>14</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>(1.799 5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>24</td>
<td>15</td>
<td>2</td>
<td>1</td>
<td>0.349 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>5</td>
<td>3</td>
<td>16</td>
<td>11</td>
<td>(0.362 3)</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 Results of the hypotheses tests of validated teacher added value for survey question four

<table>
<thead>
<tr>
<th>Student Group</th>
<th>Subject</th>
<th>$n_1$</th>
<th>$x_1$</th>
<th>$n_2$</th>
<th>$x_2$</th>
<th>Test Statistic</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
<td>141</td>
<td>88</td>
<td>83</td>
<td>48</td>
<td>0.677 8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>A103</td>
<td>44</td>
<td>35</td>
<td>32</td>
<td>29</td>
<td>(1.307 8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>50</td>
<td>29</td>
<td>17</td>
<td>4</td>
<td>2.455 8</td>
<td>***</td>
</tr>
<tr>
<td>3rd year</td>
<td>Total</td>
<td>73</td>
<td>47</td>
<td>26</td>
<td>17</td>
<td>(0.091 7)</td>
<td></td>
</tr>
<tr>
<td>4th year</td>
<td>68</td>
<td>41</td>
<td>57</td>
<td>31</td>
<td>0.665 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd year</td>
<td>A103</td>
<td>34</td>
<td>26</td>
<td>17</td>
<td>15</td>
<td>(0.997 6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>39</td>
<td>21</td>
<td>9</td>
<td>2</td>
<td>1.711 8</td>
<td>**</td>
</tr>
<tr>
<td>4th year</td>
<td>A103</td>
<td>10</td>
<td>9</td>
<td>15</td>
<td>14</td>
<td>(0.301 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A201</td>
<td>11</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>2.057 1</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>A202</td>
<td>12</td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>0.909 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A203</td>
<td>12</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>1.297 2</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>A204</td>
<td>14</td>
<td>9</td>
<td>10</td>
<td>6</td>
<td>0.213 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A205</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td>(0.837 4)</td>
<td></td>
</tr>
</tbody>
</table>

Where:

*** *** indicates significance at a level of 0.1%

**** * indicates significance at a level of 1%

** indicates significance at a level of 5%

IIII II indicates significance at a level of 0.5%

III III indicates significance at a level of 2.5%

IIII indicates significance at a level of 10%
— subject A203 for the fourth year student group (Table 3 only); and
— subject A205 for the fourth year student group (Table 4 only).

This implies that the student group which does not conceive that teaching added value is significant attains higher exemption rates than the student group which does conceive that teaching added value is significant. Based on the assertion that teaching adds significant value from §3.20, such a circumstance is counterintuitive, and hence requires deeper consideration. To understand the cause of this result, it may be appropriate to consider the results derived by Naser & Peel (op. cit.). As discussed in §3.4, student effort is found to be a significant factor influencing student performance (Naser & Peel, op. cit.). The Honours self-selection effect regarding student effort is previously considered in §§5.3.16.3. Hence, it may be necessary to further subdivide the student responses in tables 3 and 4 according to some measure of student effort. Such a subdivision would allow the following supposition to be examined, that is, that students who put in significant effort towards their studies but who do not necessarily conceive that teacher added value is significant may perform better in examinations than those students who conceive that teacher added value is significant but who do not necessarily put in significant effort towards their studies. This truly resonates with actuaries who recognise that self-effort is a key element in passing the actuarial examinations.

5.4.10.3 The lack of conclusive evidence mentioned above is a result of the very small sample sizes tested, see §§5.2.4, and, as such, the results shown above in tables 3 and 4 are not credible. For example, inspecting Table 3, a sample size of $n_2 = 4$ for subject A201 (Financial Mathematics) within the third year student group is extremely susceptible to changes in any individual response, i.e. a change in only one of the four responses would significantly alter the results of the hypotheses test performed. Hence, from the above results, any conclusive evidence is unable to be drawn that there exists ‘validated value’, as it is defined in §§5.3.1. The issue of credible data, or lack thereof, should be reviewed and possible solutions considered, such as co-operation with other South African universities offering actuarial science programmes, or aggregating more years of data, i.e. further circulations of the survey questionnaire in later years.

5.4.10.4 Not only are the small sizes of the samples problematic, but there may be distortions created through the influence of additional factors not allowed for, i.e. student effort as mentioned in §§5.4.10.2. As such, there are likely to be other influential endogenous and exogenous factors not considered in the tests described in §§5.4.5–9. This would indicate that more sophisticated methods of testing the relevant hypotheses should be explored.

6. CONCLUSION
6.1 Research Questions
6.1.1 The academic accounting literature does confirm with some degree of statistical significance that teaching adds value in the context of professional courses. Furthermore, the actuarial science students surveyed in this paper conceive that
teachers’ added value is significant overall, aggregated across all student years and subjects investigated.

6.1.2 Based on the key question of the survey, question four, teachers are found to add value to students with regard to all subjects at the most significant level of confidence, with the exception of subject A205 (Financial Economics), for which the null hypothesis is rejected only at a lower significance level (0.5%). The authors have suggested that subject A205 (Financial Economics) may be suffering from a poorly structured core reading that may be distorting the students’ conceptions.

6.1.3 Based on the key question of the survey, question four, second and third year students conceive that teachers add value at a strongly significant level. For fourth year students, however, the results indicate that teacher added value is negligible. The authors suggest that a possible reason for this is that fourth year students exhibit a greater extent of self-selection with regard to work ethic and motivation.

6.1.4 Based on the key question of the survey, question four, second year and third year students conceive that the teacher added value is strongly significant for each subject surveyed. For fourth year students, however, the results indicate that teacher added value is negligible for all subjects, except for subject A301 (Actuarial Risk Management), which is significant at the highest level of confidence tested. The authors suggest that fourth year students are also prone to hindsight bias, believing that the technical courses in previous years of study were relatively easy with hindsight.

6.1.5 Subject A201 (Financial Mathematics) is the only actuarial science subject where, if students appreciate the value of teachers, they are more likely to achieve the ASSA examination exemption standard, at a statistically significant level of confidence. The very small sample sizes tested, however, severely reduce the credibility of any inferences.

6.2 Additional Research Areas

6.2.1 The entire spectrum of education research in actuarial science, particularly with a South African focus, is virgin territory. The only relevant research found covered the change to a South African-based actuarial science education system and the consideration of normative skills development.

6.2.2 More data is required for better analyses. One way of achieving this is through co-operation between South African universities with accredited actuarial science programmes. With greater scope and volume of data, more sophisticated models may be considered and applied. This will allow for tests on the influence of a range of endogenous and exogenous factors on student performance.

6.2.3 How the level of the course, for example, F series (higher-order) versus A series (technical), impacts the teaching approach, appreciation and effectiveness of teaching, needs to be investigated.

6.2.4 ASSA subjects A103 (Finance and Financial Reporting) and A205 (Financial Economics) exhibit some mixed results, indicating that these subjects should be investigated more deeply.
ACKNOWLEDGMENTS
The authors acknowledge the help of their colleagues in the School of Statistics and Actuarial Science at the University of the Witwatersrand, who reviewed and administered the questionnaire.

REFERENCES
APPENDIX A
Survey Questionnaire

A.1 The following is an outline of the survey questionnaire distributed to actuarial science students, as described in §5.1:

1) Do you have the exemption for A103 (Finance and Financial Reporting)?
   a) Yes
   b) No

2) How many times have you sat an exam for A103 (Finance and Financial Reporting)?
   a) 0
   b) 1
   c) 2
   d) 3
   e) More than 3

3) For A103 (Finance and Financial Reporting), how helpful was the Core Reading (the material provided by the Institute and Faculty of Actuaries) in preparing for the exam?
   a) Relyed solely on the core reading
   b) Relyed mainly on the core reading
   c) Fair split between the core reading and lectures and lecture material
   d) Relyed mainly on lectures and lecture material
   e) Relyed solely on lectures and lecture material

4) For A103 (Finance and Financial Reporting), how confident would you be in sitting the exam without any lecture support (including tutorials and consultations)?
   a) Not confident at all
   b) Slightly confident
   c) Fairly confident
   d) Reasonably confident
   e) Extremely confident

5) In your opinion, what primary function does the lecturer for A103 (Finance and Financial Reporting) fulfil?
   a) Cover the core material
   b) Cover the core material, whilst explaining some difficult concepts
   c) Cover the core material, whilst providing explanation and practical applications
d) Providing explanation and practical applications using the core reading as a guide

e) Discussing in depth the broad syllabus objectives

A.2 The above questions are repeated for each of the subjects listed in ¶5.1.2 to form part of the complete survey questionnaire. Note that specific student groups were surveyed only on the subjects that each group had completed or were currently studying, e.g. second year students were surveyed only on subject A103 (Finance and Financial Reporting) and subject A201 (Financial Mathematics)

A.3 Note that the responses to survey question five above were not used in the research of this paper, but provides material for potential further research.
APPENDIX B

Extract of the Responses to the Survey Questionnaire by Second Year Students for Subject A103 (Finance and Financial Reporting)

B.1 The following is an illustration of the survey responses by second year students applicable to subject A103 (Finance and Financial Reporting):

<table>
<thead>
<tr>
<th>Student</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
<td>A</td>
<td>D</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>A</td>
<td>C</td>
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<td>C</td>
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B.2 The data was stored and analysed using Microsoft EXCEL. Responses for other combinations of student year and subject are similarly captured. Blank cells indicate non-responses.