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The relevance of teaching traditional measurement techniques to undergraduate quantity surveying students.

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Abstract.

Measurement of quantities is a core skill which must be inherent in all graduates from Quantity Surveying courses. Many students find this subject difficult to grasp, and the learning experience can be problematic especially in the first semester of first year. This is not unique to measurement as in many cases first year students are in the process of adapting to a new stage in their life, along with attempting to master many new subjects (Cottrell, 2008). This is reinforced by Johnston (2010) who highlights the many challenges being experienced by first year students and observes that “entering first year is one of the most powerful elements of the university experience” (Johnston 2010, p4). The method of delivery generally favoured by lecturers on measurement modules focuses on traditional manual measurement techniques, which some may argue, contradicts current work practices. In industry, the widespread utilisation of computerised systems has to a great extent made the labour intensive manual processing of dimensions redundant. Many commentators within the Quantity Surveying profession question the efficacy of traditional lectures for students who will eventually be employed in a computerised environment. Blight (2000) investigates the merits and deficiencies of traditional lectures, and points out that “lecturing is the most common method when teaching adults, in spite of opportunities for innovation provided by changing technology.” (Blight 2000, p3). This paper sets out to establish the student’s perspective on teaching methods currently in usage on measurement modules, and their views on the relevance of learning traditional manual techniques. My underlying philosophy is in line with (Macfarlane 2004 p.7) “University lecturers are often involved in preparing students for the demands of professional life”. As my lectures deal with a practical technical discipline, there is a close relationship with industry. Using a quantitative methodology, I have compiled and analysed student’s views with regard to teaching on measurement modules, and it’s relevance to current practice in the Irish construction industry. My findings illustrate an overwhelming support amongst students for retention of traditional teaching methods, enhanced by better access to current measurement software.

Keywords: Measurement, Quantity Surveying, Computerised Measurement.

Introduction.

The Quantity Surveying profession has a long distinguished history in providing financial expertise to the construction industry for over 250 years. The earliest records of the existence of a Quantity Surveying firm are in Reading dating back to 1785, and the first method of measurement originated in Scotland in 1802 (Aston 2007). Initially, development of the profession took place mainly within what is now the Commonwealth, then spread to other parts of the world. The Australian Institute of Quantity Surveying inform us that the term “Quantity Surveyor” originated from the Bill of Quantities, a document which itemises the quantities of materials on a construction project (Schick 2010). While Hore (2010) maintains that one of the principle activities of the client’s Quantity Surveyor is the preparation of bills of quantities, and gives much consideration to the merits of this document. The preparation of the Bill of Quantities for a particular project involves the measurement or “take-off” of quantities for various items of work from design drawings prepared by the project architect and engineer. The quantities are measured in accordance with a defined set of rules and definitions known as a Method of Measurement. Different jurisdictions have their own distinctive methods of measurement which have evolved over the years. However, most methods abide by similar principles, and once a practitioner is conversant with the core principles of measurement, it is relatively straightforward to adapt to other methods. This paper explores how measurement modules are delivered on undergraduate courses in light of technological advances in computerised measurement quantification.

The Society of Chartered Surveyors (SCS), the professional institution representing Irish quantity surveyors, have always emphasised the importance of the measurement of quantities as a core skill which must be inherent in all graduates from Quantity Surveying courses. The SCS provides graduates with a comprehensive list of core competencies which must be evident in all aspiring members and measurement and costing of construction work is a fundamental requirement (Curtin 2010). As a lecturer on the Construction Economics and Management Degree course at Dublin Institute of Technology, I deliver modules on measurement to first and second year students. Many students find this subject difficult to grasp, and the learning experience can be problematic especially in the first semester of first year. I can empathise with these students, as I experienced difficulties with understanding the principles of measurement as a student twenty years ago. I am constantly investigating new approaches to teaching measurement and this is the inspiration for this paper.

There is unease within the surveying profession that standards of measurement have decreased over the last ten years. Earl (2009) suggests that if Quantity Surveyors don't define and implement professional measurement standards, then other professionals may fill the void. With the Quantity Surveyor's role diversifying into Project Management, Life Cycle Costing, etc, there is a danger that they may neglect or become complacent over skills which have traditionally been the nucleus of the profession. Earl (2009) cites comments made by colleagues: "Quantity Surveyors don't measure" and "Measurement is a technician's job" as generic comments which could erode profession's commitment to high standards. He emphasises that "as part of cost control, we can't escape from the need to break down the cost of building works into enough detail so our clients understand what they are buying and what other costs they may need to budget for" (Earl 2009 p16).

Having established the importance of good measurement practice as a core skill which is the corner stone of a Quantity Surveyor's education, I will explore the pedagogy surrounding the delivery of measurement modules with a focus on the student's perspective. There is increasing pressure from industry to make quantity surveying courses more focused on the key skills required for the workplace. This situation is not unique to the surveying discipline, as observed by Johnston (2010), who advises that there are many factors supporting academic change, and that "allied to this scenario for academic change is the vastly increased demand for higher education to be economically relevant, and in particular for degrees to develop specific employment related skills in addition to teaching knowledge of academic disciplines."(Johnston,2010, p6). This is supported by Blight (2000), who advises that students want their studies to be relevant to their future careers. The philosophy of mirroring industry is supported by Macfarlene (2004) where he encourages the introduction of real life situations or problems which have happened in the past to back up lecture material. This is encouraged by Reece Walker (2005) with the quotation: "Students are likely to work in small groups in industry and commerce, and in consequence we have a moral obligation to use such approaches in our controlled environments" (Reece Walker 2005 p.126). These educational experts set the stage for my own examination of teaching methods relating to measurement modules, where the reoccurring theme is relevance to industry. The existing pedagogy surrounding the delivery of measurement modules include traditional lectures supplemented by tutorials, where students are divided into smaller groups. The tutorial gives the students an opportunity to apply new knowledge gained during lectures, by means of measuring quantities from various drawings which are provided, giving students a flavour of workplace

practice. However, the applied measurement carried out during these tutorials is in the majority of cases manual in nature.

In the workplace prior to 1990, measurement was carried out manually using hand written dimension sheets, which upon completion were transferred into Bill of Quantities format via type-writer and later using word processors. From an industry perspective, this process was predominantly confined to history with the onset of computerised measurement from the early 1990's onwards. Software packages such as Buildsoft allowed the Quantity Surveyor to enter the quantity dimensions directly into a computerised programme, which completed all calculations and produced an instantly formatted ready to print document. In the last five years, there have been further advances with the introduction of three dimensional modelling packages such as BIM (building information models), where drawings can be uploaded and associated quantities extrapolated from the model. Despite these radical systemic changes in the Quantity Surveyor's role, this is not fully incorporated into measurement modules at undergraduate level. The method of delivery generally favoured by lecturers on measurement modules focus on traditional manual measurement techniques, which some may argue contradicts current work practices (Hodgson 2010). The overwhelming majority of Quantity Surveyors in industry are fulfilling the measurement function via means of advanced computer software; hence the question must be posed: Is the practice of teaching traditional manual measurement an outdated and redundant modus operandi?

Skills of Measurement

In order to establish a platform from which the merits of good teaching practice in relation to measurement can be critiqued, the key skills of measurement must be identified. Quantities of construction work are used for several purposes in construction. Pickens and Jagger (2005) who are Quantity Surveyors, described measurement and quantification as a process concerned with converting construction drawings into words and numbers in accordance with a strict set of rules. Nani and Adjei-Kuni (2007) state that the quantities are usually compiled into bills of quantities which are used to establish an estimate for construction cost and subsequent control of the construction work. Fortune and Skitmore (1993) give a comprehensive summation of traditional measurement skills and competencies, and identify the essential attributes of a person quantifying construction work. These include a thorough

knowledge of building construction: acquaintance with the ordinary rules of measurement: knowledge of the customs of each trade; tact; patience; accuracy; energy; common sense; initiative; and imagination to visualise building design details. Willis and Newman (1988) also ponder on these attributes, and also add the ability to write clearly, take care, think logically and possess a sound knowledge of building materials. Measurement can also be undertaken in contractor's organisations, and in this setting Hodgson (2010) feels that a good basic numerate education is invaluable, along with site experience, ability to read and interpret drawings, a neat, methodical and tidy habit, ability to cope with vast amounts of paperwork: curiosity: confidence and the flexibility to pick up useful information. He also finds that four overall characteristics must be present in the practitioner for good measurement to follow, and they are: good organisational ability: intuition; application: and aptitude.

The skills and competencies outlined above are consistent with traditional practice, and are enshrined in traditional modes of delivery for this subject. Many commentators within the Quantity Surveying profession question the efficacy of traditional lectures for computer literate students (Hodgson 2010), and should the teaching of manual take-off be phased out? They also observe that the challenge of evolving pedagogy to meet the needs of modern students is daunting, but say that educators should note that this generation values education. Furthermore they emphasise that these students learn in a different way than their predecessors did, but they do want to learn. My experience of students on Quantity Surveying courses is that they do acknowledge that measurement is a core subject and must be mastered if they wish to pursue a successful career in this field. Hence, there is generally an enthusiasm to excel in this subject which may not be evident in more peripheral modules on the course. Race (2001) advises that "whatever sort of training we think about or whatever sort of educational experience we consider, the one thing they all need to have in common is that they lead to effective learning."(Race 2001, p1)

A significant challenge for lecturers delivering measurement is not just the measurement take off procedure in itself, but to ensure that students have sufficient knowledge and understanding of construction technology to enable them to measure. An in-depth knowledge of measurement technique will be inadequate if the student does not possess a technical knowledge and understanding of building or civil engineering technology Seeley (1999). With this in mind, the delivery of measurement modules can not be considered in isolation. As

there is a void in the student's understanding of construction technology, it is intrinsically linked to that student's grasp of measurement. It must be acknowledged that in the early years of a Quantity Surveying undergraduate course, students are required to learn how to measure, however many of them do not yet have this underpinning knowledge and understanding.

There are many factors that lead to good teaching and learning on measurement modules, and it would be simplistic to conclude that computerisation of all aspects of the course will be a panacea for all the inherent problems. Browne and Race (2002) find that it's not unusual for lecturers and students to have completely different views of what lectures are for, which can lead to all kinds of unsatisfied expectations and misapprehensions. Blight (2000) points to motivation as being a key component of student learning, and observes that "there's only one thing more contagious than enthusiasm and that's lack of it." (Blight 2000, p59). Although manual measurement is no longer used from a commercial point of view in the workplace, its value as a learning tool should not be underestimated. Race (2001) talks about shared learning experiences, opportunities to learn by doing and the way students need to make sense of what they already know. In my opinion, manual measurement carried out by small groups in tutorials enhances these vehicles of learning where usage of measurement software packages would not.

Measurement and the I.T. revolution.

Hore (2010) alludes to the significant changes the quantity surveying profession has experienced over the past decade in terms of scope, and type of services provided, and the changing role has come about due to the demands of the construction industry and clients involved. This changing role centres on delivery of service where a fastidious approach is expected with more onerous deadlines. With the introduction of fast track procurement, there is a necessity for faster bill of quantities production, as well as cost planning, value management, risk management, etc (Cartlidge 2006). Some of these changes have been possible due to the advancement of information technology in this area. Cartlidge (2006) suggests that Quantity Surveyors have been greatly impacted by the IT revolution, the speed of which has been substantial. This is quite plausible as the majority of duties carried out by the quantity surveyor involve calculations and quantification which to a great extent lend themselves to computerisation (Hore 2010). This sentiment is supported by Lee and Trench (2010) who advise that the widespread utilisation of computerised systems has to a great

extent made the labour intensive manual processing of dimensions redundant, with measurement and bill production now often part of an automatic process. However Lee and Trench (2010) reinforces that when undertaking the measurement of quantities, it is important to understand the process involved in properly framing descriptions, and the structure of the bill. Where computerised systems are used, the quantity surveyor can ensure that the bill is complete and correct and that the necessary level of information is being provided to the contractor for pricing.

Computerised measurement is evolving rapidly in terms of technology and sophistication. The original computerised systems originated in the early nineties where measurements were taken from drawings and entered onto various software packages resulting in a printable bill of quantities. This has evolved in the last five years to software packages whereby drawings can be electronically uploaded and measurements extrapolated using the package, and formatted into a bill of quantities without having to refer to hard copies of the drawings. It must be stressed that the latter is in its infancy, and does not enjoy widespread usage at present. This is mainly due to up skilling requirements for practitioners and the costs associated with this software. In many cases there is reluctance on the part of Architects to make electronic versions of their drawings available. However there is evidence of progressive attitudes to this technology in industry. Breetzke (2006) observes that with the increased use of electronic measurement by quantity surveyors, and the wide array of file types that are distributed by the professional teams, it is essential to compile a document on the protocols to be adapted.

CITA, Construction IT Alliance was founded in 2001 with the aim of harnessing the potential of information and communications technologies for the Irish construction industry. The key driver in the development of this organisation was the need to increase the extent of IT knowledge within the Irish construction sector (Hore 2010). Alan Hore, one of the founding members of that organisation is a chartered quantity surveyor who has given impetus to research surrounding information technology in the quantity surveying field. With regards to computerised measurement, the most commonly used application in Ireland is the Buildsoft suite of software products (Hore 2010). This is a user friendly suite of software products which allows measurement take off to be entered easily from drawings and formatted into a printable bill of quantities, and is used in the majority of private quantity surveying practices and contracting organisations alike throughout the country (Boyle 2010). There are many

other providers of computerised measurement products such as: CIT, Cato, CostX, Allplan, Masterbill, etc, which all have developed their own distinct systems for delivering a similar end product. The most recent developments in IT include Building Information Modelling (BIM) which some commentators suggest will in future revolutionise the production of bills of quantities. In a recent research project carried out by CITA, the effective use of BIM in the production of bills of quantities was demonstrated. The software allows for the production of a 3D CAD model from which quantities can be extracted. There is general acceptance in the market that these technologies are relatively immature in respect to the production of accurate quantities, and that they do not effectively integrate with method of measurement rules (Hore 2010). However Hooper (2010) in his article on “twenty technologies that are helping to shape the future of the built environment” feels that BIM tools can simulate the entire construction sequence beforehand, and can inform on cost effective strategies. It’s not hard to speculate that this is where the future lies.

Having examined the new technology surrounding measurement and the quantity surveying profession in general, the relevance of teaching traditional measurement methods comes into question. To investigate whether traditional teaching methods are relevant, it is vital to gauge the opinions of students who are currently in the process of learning measurement and make an assessment of their views.

The central question regarding the teaching of measurement.

The rules for measuring are complex, and are designed for experienced practitioners (Hodgson 2010). Many students are highly computer literate and expect to engage with their studies using computer systems. However Biggs (2003) sees the dangers associated with too much emphasis being placed on information technology alone, and feels that some lecturers have a viewpoint that “just using information technology will do the trick, and use IT and teaching problems will disappear.” (Biggs 2003 p213) which he advises are dangerously misleading.

It has been established that in industry the quantity surveying profession has embraced computerisation, and that measurement is now carried out utilising appropriate software. However modules on undergraduate quantity surveying courses relating to measurement retain a large element of traditional manual measurement. The central question surrounds the relevance of retaining such methods from the student's perspective, in order to meet the required learning outcomes regarding measurement.

My opinion, as a practicing quantity surveyor for over fifteen years is that in order to grasp the basic principles of measurement, traditional techniques are the ideal vehicle to acquire the basic skills. If students are not informed with these methods and introduced to computerised measurement systems in isolation, they may become blinded by technology, and never grasp the basics. I strongly advocate the use of computerised systems as a learning tool; however I feel that it should be introduced in parallel to traditional methods. This opinion is not universally accepted, and I have debated this issue with colleagues in other third level institutions. The opposing view on this argument include those who advocate the use of software only when teaching measurement, and draw on teaching practices on other courses. For example: when teaching computer aided design, the lecturers on these courses do not resort to teaching traditional draughting with a drawing board and tee square. The most appropriate method of establishing the relevance of teaching traditional measurement methods lies with the learners themselves, the students who are currently studying this subject.

Methodology.

Methodology is “the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choice and use of methods to the desired outcomes” (Crotty, 1998, p3). The methodology that I have chosen to research student attitudes is quantitative in nature in the form of a survey. In my opinion, this is the most suitable methodology to research attitudes to the argument raised. I deliver two modules on measurement to second year students on the degree course in construction economics and management at Dublin Institute of Technology. I feel that this is the appropriate group to undertake a survey on their opinions relating to their experiences of learning the skills and techniques surrounding measurement.

The principle reasons for choosing this group are as follows:

- (a) The students are relatively new to the subject, and their experiences of learning measurement for the first time are still fresh in their memories.
- (b) Their initial education on the subject was through teaching of traditional manual measurement quantification, however in their third semester they would have been exposed to a number of computerised measurement software programmes with a particular emphasis on the use of buildsoft. Hence these students have experience of both methods and can give an informed commentary on their learning experiences dealing with both methods.
- (c) The group of students in question were enthusiastic about participating in the survey, and eager to give honest opinions on the topic.

The group of students were presented with a detailed questionnaire designed to gauge their opinions on current teaching methods relating to measurement. I wanted to understand and identify the benefits and limitations of current teaching practices from the student's perspective. The overall objective of the study being to determine whether radical revisions are necessary to enhance students learning experiences on modules of this nature. The questionnaire contained six questions, five of which utilised a five point Likert scale format. These questions were precise in nature, requiring an indication by the students of their level of agreement or disagreement with the statements made relating to the teaching of measurement. The students were given an opportunity with question six to offer opinion on improvements which could be implemented.

A total number of 39 students were registered on the course with 32 students taking part in the study, which is a representative sample at 82% participation. The students in question were in the early weeks of their second semester of second year when presented with the questionnaire. They had all completed three modules on measurement at that time. None of the students surveyed had any practical experience of measurement in the workplace.

Findings and discussion

I analysed the questionnaire results to gauge attitudes towards usage of traditional manual measurement techniques as a learning vehicle. The results, although far from unanimous on the subject, were generally supportive of the retention of traditional teaching methods.

Table 1. Student responses to questions posed.

	Questions	Agree (5)	(4)	(3)	(2)	Disagree (1)
1	Teaching of traditional manual quantification is still relevant despite advances in computerised quantification.	80%	10%	5%	2%	3%
2	More emphasis should be placed on computerised measurement in the first two years of your course.	70%	10%	10%	9%	1%
3	Traditional manual quantification should be ignored in light of systemic changes in industry.	1%	1%	5%	3%	90%
4	Knowledge of construction technology is more important than the methods used to quantify works.	40%	50%	5%	4%	1%
5	Students are provided with adequate tuition on the wide spectrum of computerised measurement software systems	1%	1%	2%	1%	95%

Although there was not unanimity on the relevance of teaching manual quantification, there was a strong endorsement of its usage with over 80% of replies strongly agreeing. Table 1 lists the main questions detailed on the questionnaire with the exception of question six, which was a commentary question. Question six was only to be answered if the student was in agreement with question one, and was an exploratory open question on the student's own opinion on why traditional manual measurement was still relevant. Naoum (2007) advises that there are two main methods used to analyse the type of data compiled from question six: the descriptive statistics method and the inferential statistics method. Naoum (2007) describes the descriptive statistics method as a straightforward method which provides a general overview of the results, with the responses either allocated percentages, or numbers. Although there was a diverse range of answers to question six, a number of common themes existed in many of the responses. These themes are outlined below, along with the associated percentage of student responses.

- (a) Manual quantification gave students a solid grounding in the basic principles of measurement and the core skills associated with that subject which was vital prior to using a computerised system. (50%)
- (b) The necessity of being able to trace the origins of all measurements taken which is inherent in manual quantification trained students to be meticulous in their approach which was advantageous when subsequently utilising computerised systems. (30%)

- (c) Computerised measurement packages are designed, simulating the core principles of manual measurement, hence add to the students understanding of the packages. (20%)
- (d) Learning the principles of measurement in itself is an onerous undertaking without being faced with complicated software packages from the start. (20%)

Although the overwhelming majority of students favoured the retention of manual measurement on these modules, there was a high percentage of students dissatisfied with the amount of computerised applications included. This is illustrated in table 1, where 80% of students surveyed feel that more emphasis must be placed on computerised systems in the first two years of the course. This is emphasised by the fact that 95% of students surveyed felt that they were poorly informed on the computerised packages available in this field. This survey also reinforces statements made earlier in this paper relating to the importance of construction technology when dealing with measurement, and that students must be proficient in this area before prescribed learning outcomes can be achieved on measurement modules. This proficiency must be supplemented by an ability to visualise drawings and understand exactly what is being measured.

When analysing the percentages relating to questionnaire responses on table 1, it could be argued that a level of contradiction is apparent. While students are stressing the importance of manual methods, they are also critical of the lack of teaching and learning surrounding computerised systems on these modules. However in my opinion their comments reflect the necessity of a dual approach when teaching measurement, and there is an onus on lecturers in this field to acknowledge these concerns and adopt a balanced approach when delivering measurement modules.

Conclusion

There is little evidence of support from the students surveyed, for the elimination of teaching manual measurement on modules of that nature. Students recognise that ability to measure and quantify construction work is synonymous with the quantity surveying profession. They acknowledge the advances made in information technology, and the importance of being well grounded in the most current software. However, they also acknowledge the contribution manual measurement makes to the learning process when coming to grips with the fundamental principles of measurement as a subject. This study concludes that manual measurement must be retained to meet required learning outcomes, and must be supplemented

and not replaced by software packages. The quantity surveying profession cannot afford to let standards of measurement drop. Earl (2009) is not exaggerating when he suggests that if quantity surveyors don't define and implement professional measurement standards, then other professionals within the construction industry may fill the vacuum. There is little argument that the rules for measuring are complex, and are designed for experienced practitioners, and that some students struggle to acquire the mix of skills and knowledge within the timeframe allowed (Hodgson 2010). This paper has investigated the challenges and approaches adopted by lecturers delivering modules in this field. There are many challenges facing would-be quantity surveyors to develop measurement skills in a changing professional environment. With ongoing evolution in the computerisation of quantity surveying technology, it would be futile not to embrace this technology in our undergraduate courses, and ensure that our graduates are conversant with the latest technology. However, embracing technology must compliment existing tried and tested teaching practices and not replace them. The vast majority of students involved with this study had positive attitudes to the benefits of being conversant with traditional manual measurement techniques. We must acknowledge this feedback being compiled from students who are actively engaged in the learning process. The students in question, although novices to this subject are knowledgeable on what aids their learning and their opinions should not be ignored.

References

- Aston, G. (2007). *One hundred years of Quantity Surveying*, London: Hinds Publishing.
- Biggs, J. (2003). *Teaching for Quality Learning at University*. UK: Open University Press.
- Blight, D. (2000). *What's the use of lecturers?* USA: Jasley-Bars.
- Boyle, G. (2010). Show Buildsoft! Retrieved April 2, 2011, from www.bssssoftware.com
- Breetzke, K. (2006) Service – Project Information Management, *RIAI Journal*, 234(2), 61-62.
- Browne, S., & Race, P. (2002). *Lecturing, A practical guide*. UK: Palgrave.
- Cartlidge, D. (2006). *New Aspects of Quantity Surveying*, Butterworth Heinemann.
- Cottrell, S. (2008). *Teaching Study Skills and Supporting Learning*. Basingstoke: Palgrave Macmillan.
- Crotty, M. (1998). *The foundations of social research*. London: Sage Publications.
- Curtin, B. (2010). SCSI AGM Speech. Retrieved May 31, 2011, from www.scsi.ie
- Earl, S. (2009). New tools for the trade. *Construction Journal*, 80(9), 6-7.
- Fortune, C., & Skitmore, M. (1993) Quantification skills in the construction industry. *Construction Management and Economics* 12(1) p.179
- Hodgson, G. (2010) *An e-learning approach to quantity surveying measurement*. UK: Loughborough University Publications.
- Hooper, B. (2010, October 11). 20 20 Vision. *Modus RICS Publication*, p.18.
- Hore, A. (2010). *Seeley and Winfields Building Quantities Explained*. London: Palgrave.
- Johnston, B. (2010). *The first year at university: Teaching students in transition*. UK: SRHE & Open University Press.
- Lee, S., & Trench, W. (2010) *Willis's Elements of Quantity Surveying*, UK: Blackwell Press.
- Macfarlane, B. (2004). *Teaching with Integrity*. London: Routledge Falmer.
- Nani, G., & Adjei-Kuni, T. (2007) *The challenges of quantifying construction works for project control in Ghana*. Paper presented at CIB World Building Congress, University of Science & Technology, Kumasi.
- Naoum, S. (2007). *Dissertation Research & Writing for Construction Students*. London: Butterworth-Heinemann.
- Pickens, D. & Jagger, D. (2005) Whither measurement, *RICS Journal*, 12(05), p.45.
- Race, P. (2001). *The Lecturers Toolkit*. London: Kogan Page Ltd.
- Reece, I., & Walker, S. (2005). *Teaching Training and Learning*. Sunderland: Business Education Publishers Ltd.

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Schick, E. (2010). A brief history of quantity surveying. *The Australian Institute of Quantity Surveyors Handbook*. Retrieved March 18, 2011, from www.aiqs.com-au/site.php?id=85

Seeley, I. (2009) *Building Quantities Explained*. UK: Palgrave.

Willis, G.(1988) *Elements of Quantity Surveying* UK: Blackhall Press.