CONSTRUCTION MANAGEMENT AND QUANTITY SURVEYING STUDENTS' PERCEPTIONS TOWARDS PRODUCTION ANALYSIS AND MEASURING QUANTITIES FOR CONSTRUCTION PURPOSES

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Students' pre-course perceptions of a module provide insight relative to their understanding and appreciation of a module and challenges that the lecturer may encounter. Furthermore, post-course perceptions can be compared with pre-course perceptions to determine the impact of the presentation of the module, if any. The purpose of the study reported on is to determine the pre- and post-course Production Analysis / Quantities perceptions of construction management and quantity surveying students, and the impact of the completion of the module, based upon a self-administered questionnaire survey conducted in a South African university. The students were surveyed at the inception and the completion of the presentation of the module at first year level. The results show that both construction management and quantity surveying students regard the quantities competencies (knowledge and skills) highly important for Quantity Surveyors and Construction Managers. The results further reveal that the Production Analysis / Quantities module will assist students in other modules such as Quantity Surveying, Site Surveying, Construction Management, and Project Management. Students are also of the opinion that the Production Analysis / Quantities module will assist them further in measuring, material management, estimating, and cost control activities. Based upon the findings it can be concluded that students have a degree of understanding and appreciation of the module Production Analysis / Quantities prior to exposure thereto, the presentation of the module had an impact on their perceptions, and they understand and appreciate the importance and role of the modules to their programmes and disciplines. It is recommended that such research be conducted on an annual basis, and a preparatory lecture 'The role and importance of Production Analysis / Quantities' should be evolved for first time Production Analysis / Quantities students.

Keywords: perceptions, production analysis, quantities, students

INTRODUCTION

The Production Analysis 1 and Quantities 1 year module is one of the core modules of the undergraduate Construction Management (CM) and Construction Economics (QS) qualifications offered respectively at the Nelson Mandela Metropolitan University. The module is lectured to a combined group of CM and QS first year students by a quantity surveying lecturer with extensive experience in the quantity surveying profession and in teaching and learning at tertiary level. The curriculum design for

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the module is structured in order to meet the requirements of the relevant accreditation bodies of the construction management and quantity surveying students.

As the module is presented to two different built environment disciplines, there is a 'need for innovative education approaches that facilitate cross-disciplinary thinking' according to Warburton (2003), and as highlighted in both disciplines' professional registration councils' accreditation reports, the research provided an opportunity to better understand the perceived perceptions of each student group at the commencement of the academic year measured against the perceived perceptions at the end of the academic year.

Furthermore, tertiary built environment qualifications are tailored to produce diplomats and graduates that are deemed suitable by employers and the built environment in general. However, the education of students has continued to challenge both academia and the industry.

REVIEW OF THE LITERATURE

Production analysis and measuring quantities for construction purposes

The measurement of building elements is a key part of quantity surveying and construction management studies. The training and knowledge of the quantity surveyor and construction manager have enabled the role of the respective professions to evolve over time into new areas, and the services provided by the modern quantity surveyor and construction manager now cover all aspects of procurement, contractual, and project cost management (Lee, Trench and Willis, 2005). Competitive tendering is one of the basic principles of most classes of business. For the purposes of tendering, bills of quantities are prepared and each competing contractor is provided with the bills of quantities, all pricing the same information. Most other procurement routes, such as design and build, and management contracting in its various forms, also involve quantification of the work in some form or other, and therefore the measurement process continues to be of importance.

Computerised and other alternative measurement systems have become more and more widely used. Different systems of measurement, setting out the rules for measuring building work are used.

Students are assumed to have knowledge of elementary building construction and simple mensuration before proceeding with the measurement of a building or structure. A contractor may well produce quantities for an estimate where only the main items for the work would have been measured. This is done for internal use and any errors are for the contractor's account. It is therefore essential for the contractor to understand how the bills of quantities are prepared in order to measure and price contract variations on the project (Lee, Trench and Willis, 2005).

The main outcome of the Production and Analysis, and the Quantities module is to enable Construction Management and Quantity Surveying students to 'take-off' quantities from building drawings in order to compile bills of quantities. Students should consider the following functions of bills of quantities as mentioned by Seeley and Winfield (1995):

- Enables all contractors tendering for a contract to price on exactly the same information;
- Provides a satisfactory basis for the valuation of variations and adjustments to the final account;

- Provides a useful basis for the valuation of monthly payment certificates throughout the contract;
- Provides a full description and quantity of each element, and could form a checklist for the contractor in ordering materials and assessing requirements in terms of labour and programming the works, and
- It can also assist in the preparation of cost analysis for use in cost planning of future projects.
- Kelly, Morledge and Wilkinson (2002) state the importance of understanding the difference between estimating and cost control, and define them as follows:
- Estimating – "The provision of an informed opinion at a particular time of what the final cost of the project is likely to be", and
- Cost control – "The management of the consequences of the design and construction processes so as to achieve value for money and ensure that the final cost does not exceed the budget."

Cost control in the construction industry is a term that is used to cover a whole spectrum of activities from inception through to the final completion of the final account for the project (Ashworth and Hogg, 2007). Furthermore, Jaggar *et al.*, (2002) refer to design cost management where the building is designed as per the model to be constructed at a specific cost, and the management ensuring that the functions of planning control and feedback are successfully brought about in terms of design, cost, time, and quality. Quantities forms a key aspect in all these various activities in which case the Production Analysis and Quantities module put a lot of emphasis on.

This research examines the association between students' pre-course and post-course attitudes and perception towards the course content. Piaget (1950) are of the opinion that individuals construct new knowledge through processes of accommodation and assimilation from their experiences, thereby incorporating new experiences into an already existing framework without changing the framework. Litzinger *et al.,* (2011) state that it is essential to prepare students to meet the professional challenges after graduation. This can be achieved by helping them build knowledge and skills that they can readily adapt to address the unusual, complex problems that they will encounter. Litzinger *et al.,* (2011) further state that knowledge should be structured around key concepts and principles to facilitate students' abilities to access and transfer knowledge to new and novel situations.

Teachers and curriculum developers have long recognised the value of analysing the subject matter to be learned by developing learning outcomes or objectives such as well-known Bloom's taxonomy. Over the past few decades, the emphasis in education has been on methods of teaching and learning and assessment. According to Harden (2002), attention has moved from an emphasis on the education process to a consideration of the product and the expected learning outcome of the students' studies. Baartman *et al.,* (2007) indicate that learning is significantly influenced by the nature of the assessment as students tend to focus their learning on what they know / think will be assessed. Baartman *et al.,* (2007) further add that two aspects seem to be common in most definitions of competence. Firstly, competence defined in terms of the integration or performance of specific combinations of knowledge, skills and attitudes that will provide evidence of the required capability. Secondly, it is defined in terms of requirements linked to a specific profession or situation.

According to the South African Qualifications Act (SAQA) (2000), competence in an outcomes based education system is too narrow, because not enough emphasis is placed on the understanding or the moral issues surrounding the action. Fraser *et al.,* (2005) are of the opinion that the traditional approach has been developed to become a 'new' more holistic or integrated approach that involves assessing a combination of attributes (knowledge, capabilities, skills and attitudes) and the performance tasks at an appropriate level or standard. According to Crafford and Smallwood (2007), the five most important competencies required by quantity surveyors as ranked by clients are cost control, estimating, measurement, plan reading, and economics of construction. Educators need to be aware of what skills and knowledge their protégés have acquired and employers should be able to identify the knowledge and skills they seek (Minister of Education, 2005).

Smallwood and Emuze (2012) mention that the practice of construction management is the ability to manage the business of construction and execute projects, using the functions of management work in the form of planning, organising, leading, controlling, and coordinating. These functions entail forecasting, programming, and scheduling competencies, the ability to delegate and develop relationships, communication and decision making abilities, and performance evaluation competencies. Smallwood and Emuze (2012) further state that the top construction management skills required, pertain to oral and written communication, planning and scheduling, estimating, project administration and management, and decision making abilities in terms of alternatives, cost / benefit ratio, return on investment, and net present value.

Teaching and learning Production Analysis and Quantities

The teaching methodology of the year-module Production Analysis and Quantities 1 has undergone some transformation and re-configuration over the past few years in order to make the course material and presentation more comprehensible. In the first year, students learn how to 'take-off' quantities from drawings of a simple single storey building for the purpose of preparing Bills of Quantities for a construction project. The students are also introduced to the process followed after the production of the Bills of Quantities for tendering purposes.

The module focuses primarily on the measuring of certain building elements such as site works, foundations, superstructure brickwork, ground floor construction, and external and internal finishes. The importance of exact quantities are accentuated and the effect thereof on a construction project. The module content is delivered in a traditional manner during formal lecture periods by a lecturer. Students are also required to attend practical sessions, which are administered by final year student assistants.

Springer and Borthwick (2004) point out that provoking a developmental shift from *knowing* to *thinking* would produce a long-standing need for learning. This would help students create learning experiences to develop higher-order thinking skills while generating interest in major and non-major modules. Added to this, the Production Analysis / Quantities module is focused towards concepts that are mostly resonant with the quantity surveying discipline, which could be challenging for the construction management students. It is thus important that the teaching and learning method should be meaningful and motivational to both groups of students.

RESEARCH

Research method

In order to explore first year students' perceptions, a quantitative research methodology was used for the purpose of this study. The sample population consisted of a total of ninety five (95) students, comprising of forty-two (42) CM, and fifty three (53) QS students registered for the module. A pre-course survey was conducted at the beginning of the first semester to determine their perceptions with respect to production analysis and measuring quantities for construction purposes. The self-administered questionnaire consisted of thirty, five-point Likert scale questions. The survey was repeated at the end of the second semester using the identical questionnaire, to obtain the post-course perceptions of both groups of students.

Eighty six (86) students responded to the pre-course survey which represents a response rate of 91% of which 45% were CM and 55% were QS students. During the post-course survey, seventy-three (73) students responded representing a response rate of 77% of which 42% were CM and 58% were QS students.

Research findings

Table 1 indicates the importance of Production Analysis and Quantities competencies (knowledge and skills) relative to Construction Managers and Quantity Surveyors in terms of mean scores (MSs) between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (low) to 5 (high). It is evident that both CM and QS students indicated during the pre-course and post-course surveys, that the knowledge and skills competencies are of high importance for both the disciplines. Both student groups also identified that the knowledge and skills competencies are between more than important to highly important / highly important (MSs > 4.20 ≤ 5.00) for both the disciplines.

Table 1: The importance of Production Analysis and Quantities competencies

Disciplines	Pre				Post			
	CM		QS		CM		QS	
	MS	Rank	MS	Rank	MS	Rank	MS	Rank
Quantity Surveyors	4.74	1	4.85	1	4.74	1	4.88	1
Construction Managers	4.59	2	4.43	2	4.58	3	4.29	2

Table 2 indicates the perceived extent Production Analysis will assist CM students in terms of understanding and performance relative to other modules in the programme in terms of MSs between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (minor) to 5 (major). The results show that the Construction Management module was ranked first followed by Site Surveying during the pre-course survey. However, during the post-course survey, Building Economics was ranked first, followed by Construction Management. Given that the MSs > 3.40 ≤ 4.20 with the exception of Building Economics (post MS > 4.20), the extent of the assistance can be deemed to be between moderate to a near major extent / near major extent. Respondents further indicated during pre- and post- course surveys that Production Analysis assists understanding and performance relative to half (50%) of the other modules between a moderate to near major extent / near major extent (MSs > 3.40 ≤ 4.20). During both pre- and post-course surveys, Environment and Services achieved MSs > 2.60 ≤ 3.40 – between a near minor to moderate extent / moderate extents. Furthermore, it is notable that during the pre-course survey Property

Economics was ranked last, while during the post-course survey, it was ranked third. Finally, the post-survey MS was lower than the pre-survey MS for 6 / 8 (75%) activities, and higher in the case of 2 / 8 (25%) – notably Building Economics, and Property Economics.

Table 2: Extent Production Analysis will assist in understanding and performance relative to various other modules

Module	Pre		Post	
	MS	Rank	MS	Rank
Construction Management	4.36	1	3.87	2
Site Surveying	4.03	2	2.39	8
Materials and Methods	3.92	3	2.90	5
Structures	3.72	4	2.58	6
Project Management	3.67	5	3.39	4
Building Economics	3.54	6	4.26	1
Environment and Services	3.26	7	2.55	7
Property Economics	3.23	8	3.55	3

Table 3 indicates the perceived extent Quantities will assist QS students in terms of understanding and performance relative to other modules in the programme in terms of MSs between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (minor) to 5 (major). Quantity Surveying was ranked first during both the pre-course and post course surveys with MSs > 4.20 ≤ 5.00 (near major to major / major extent). It is notable that less than half (38%) of the modules' MSs are > 3.40 ≤ 4.20 (moderate to near major / near major extent) during pre-course, as opposed to 50% during post course. The MS for the module Information Technology was > 1.80 ≤ 2.60 (minor to near minor / near minor extent) during both pre-course and post course surveys. Furthermore, the post-survey MS was lower than the pre-survey MS for 4 / 8 (50%) activities.

Table 3: Extent Quantities will assist in understanding and performance relative to various other modules

Module	Pre		Post	
	MS	Rank	MS	Rank
Quantity Surveying	4.83	1	4.74	1
Site Surveying	4.15	2	3.52	5
Materials and Methods	3.87	3	3.67	3
Building Economics	3.66	4	4.05	2
Property Economics	3.36	5	3.67	3
Research	3.32	5	2.83	7
Environment and Services	3.17	7	3.33	6
Information Technology	2.13	8	2.40	8

Table 4 indicates the perceived extent Production Analysis will assist CM students relative to construction management activities in terms of MSs between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (minor) to 5 (major). It is notable that during the pre- and post-course surveys, activities such as measuring quantities, cost control, estimating, preparing site layouts, and programming and scheduling were identified as the top four activities assisted by Production Analysis. It is notable that Production Analysis will assist relative to only 4 / 18 (22.2%) of the activities between a near major to major / major extent during the pre-course survey as

opposed to 3 / 18 (16.7%) during the post-course survey. Furthermore, the post-survey MS was lower than the pre-survey MS for 14 / 18 (77.8%) activities. It can be deduced that during the course of the academic year, students developed an understanding and appreciation of the importance of the Production Analysis module primarily relative to 'measuring quantities'. The activity 'resolving disputes' achieved the lowest MS and ranking during both surveys.

Table 4: Extent Production Analysis will assist relative to CM activities

Activity	Pre		Post	
	MS	Rank	MS	Rank
Cost control	4.46	1	4.26	3
Estimating	4.36	2	4.39	2
Measuring quantities	4.28	3	4.94	1
Preparing site layouts (Planning)	4.26	4	3.16	8
Productivity measurement	4.15	5	3.48	6
Material management	4.13	6	3.68	5
Quality management	4.03	7	2.65	15=
Programming and scheduling	3.85	8	3.87	4
Setting out buildings	3.77	9	2.68	13=
Resolving construction problems	3.72	10	2.68	13=
Labour management	3.64	11	3.45	7
Plant and equipment planning	3.51	12	3.03	9
Subcontractor management	3.46	13	2.77	11=
Outlining the scope of work	3.38	14	2.87	10
Health and safety management	3.15	15=	2.61	16=
Resolving design problems	3.15	15=	2.61	16=
Temporary works design	3.00	17	2.77	11=
Resolving disputes	2.49	18	2.55	18

Table 5 indicates the perceived extent Quantities will assist QS students relative to quantity surveying activities in terms of MSs between 1.00 and 5.00, based upon percentage responses to a five point scale of 1 (minor) to 5 (major).

Table 5: Extent Quantities will assist relative to QS activities

Activity	Pre		Post	
	MS	Rank	MS	Rank
Preparing Bills of Quantities	4.72	1	4.88	1=
Measuring	4.64	2	4.88	1=
Preparing final accounts	4.47	3	4.67	4
Estimating	4.36	4	4.83	3
Cost control	4.28	5	4.62	6
Preparing valuation payment certificates	3.85	6	4.64	5
Research in the built environment	3.74	7	2.93	18
Strategic planning of built environment projects	3.70	8	3.52	9
Property valuations	3.55	9	4.12	8
Resolving construction problems	3.52	10	3.05	16
Resolving design problems	3.43	11	3.14	14=
Feasibility studies	3.38	12	4.26	7
Maintenance management	3.34	13	3.31	11=
Risk management	3.28	14	3.31	11=
Value engineering / management	3.21	15	3.38	10
Tax assessment on built environment projects	3.13	16	3.14	14=
Resolving disputes	2.68	17	3.00	17
Procurement advice	2.51	18	3.29	13

Respondents indicated during the pre-course survey that the Quantities module will assist relative to 6 / 18 (33.3%) of the QS activities between a near minor to moderate / moderate extent (MSs > 2.60 ≤ 3.40), and between a near major to major / major extent (MSs > 4.20 ≤ 5.00) relative to only five (27.8%) activities. However, during the post-course survey students are of the opinion that 9 / 18 (50%) of the activities will be assisted between a near minor to moderate / moderate extent (MSs > 2.60 ≤ 3.40), and 7 / 18 (38.9%) activities between a near major to major / major extent (MSs > 4.20 ≤ 5.00). Furthermore, the post-survey MS was lower than the pre-survey MS

for only 5 / 18 (27.8%) activities. It is clear that the QS students realised the extent of the module's assistance relative to QS activities during the course of the academic year. It is further notable that 'Research in the built environment' is ranked last during the post-course survey.

DISCUSSION

The respondents understand and appreciate the importance of knowledge of 'Production Analysis and Quantities competencies' to construction managers and quantity surveyors. The CM students understand and appreciate the extent to which the Production Analysis module will assist them in understanding and performance relative to other modules in their curriculum such as Construction Management, Building Economics and Property Economics. A similar outcome is experienced with QS students indicating that the Quantities module will assist them in understanding and performance relative to their Quantity Surveying, Building Economics and Property Economics modules. The respondents understand and appreciate the importance of knowledge of Production Analysis and Quantities in terms of their studies, in particular towards their major modules respectively. Furthermore, it is evident that both CM and QS students are of the opinion that their respective modules will assist them in measuring quantities, estimating and cost control relative to their working activities.

Relatively similar results were obtained in a survey conducted by Dent and Smallwood (2014) where CM and QS students' perceptions towards their Building Economics module at the Nelson Mandela Metropolitan University were surveyed. A survey conducted by Allen, Smallwood and Emuze (2013) relative to built environment students' perceptions of the Environment and Services (E&S) module at the Nelson Mandela Metropolitan University, also revealed similar results, which determined that students do understand and appreciate the importance of knowledge of E&S to their disciplines.

CONCLUSIONS AND RECOMMENDATIONS

This study was initiated in order to determine the perceptions of CM and QS students regarding production analysis and measuring quantities for construction purposes. Effective teaching is fundamental to effective learning and improving outcomes for students. Descriptive standards could be explored to guide the outcomes for higher levels of competence.

It is evident that both the CM and QS students regard Production Analysis and Quantity Surveying competencies as important for both the Construction Manager and Quantity Surveyor during the pre- and post-course surveys.

CM students are of the opinion that the module Production Analysis will assist in understanding of their major module Construction Management, while the QS students indicated that the Quantities module will assist them in one of their major modules, namely Quantity Surveying. It is notable that both groups of students have indicated that the Site Surveying module will be affected during the pre-course survey, but less so during the post-course survey.

It is also notable that there is a substantial difference between the quantity surveying students' pre- and post-course survey perceptions in terms of the extent to Quantities will assist in understanding and performance relative to various other modules.

Furthermore, quantity surveying students have realised the relevance of the module relative to the quantity surveying activities during the course of the academic year. Both CM and QS students are of the opinion that the Production Analysis and Quantities module assists in terms of measuring and preparing bills of quantities.

It is recommended that the CM and QS students should be informed during their first lecture regarding the importance of the Production Analysis and Quantities module, the impact thereof relative to their respective disciplines, and the effect thereof on other modules. Similar research should also be conducted for other modules relative to the CM and QS curricula. Furthermore, future research should be conducted to determine the perceptions of CM and QS graduates relative to the significance of the Production Analysis and Quantities modules in their workplace.

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