Does Quality Assurance Enhance the Quality of Computing Education?

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Abstract

Delivery of "quality" education is a major element of the mission statements of the world's tertiary institutions. Quality has emerged as an important academic performance metric and can have significant impact on the reputations of individuals, departments, faculties and institutions. This paper explores quality and quality assurance (QA) from several perspectives, production and manufacturing, service provision and personal growth, relating them to current QA frameworks and practices in computing.

*Keywords:*quality, assessment, computing education

1 Introduction

Fundamental to the discussion of educational quality is a discussion of the epistemology of tertiary education. This paper argues that a shift in the focus of universities towards providing broader education, to a larger segment of the population, has changed our view of education. The perception of universities as seats of learning engaged in inculcating students with academic values and knowledge as part of a process of self discovery and personal growth, has given way to one of providing a product to a customer. Defining education as a commodity transforms our world view, making students into customers, and the widespread practice of charging tuition fees can be construed as presenting education as a product or service.

Retail and production companies have developed sophisticated mechanisms for quality control. Total quality management(TQM) approaches integrate quality control and production process refinement to achieve high levels of output quality and internal production accountability. In areas such as science, and perhaps especially engineering, process monitoring for quality control and management is a natural part of commercial operation and may even be an explicit part of the curriculum. Application of similar approaches to educational quality assessment and process is evident as in initiatives such as CDIO increase in significance (Brodeur & Crawley 2009).

Another significant factor driving the introduction of QA is the global trend emphasising application of managerial practices to education, for academic administration (Hattie 1990, Soutar & McNeil 1996). The corporatization of tertiary institutions also leads naturally to the application of business models of production and quality assurance of process and product, as is evident in a number of recent publications dealing with the evaluation of marketing and service scales developed in other sectors (Abdullah 2006, Soutar & McNeil 1996).

Are managerial and quality practices from production and service corporations really appropriate in computing education? This paper explores approaches to QA and TQM frameworks. We examine how existing practices might fit into such a framework, and propose new strategies with which to address academic content quality and pedagogy. Content is often addressed during accreditation activities, while issues such as pedagogy and progression in learner maturity are not often taken directly into account.

This paper approaches the issue of educational quality from three perspectives, production, service provision, and learning development.

2 Perspectives on Education and Educational Quality

2.1 Production

Education provision can be viewed as the process of equipping students with a set of skills and competencies. Assessment of educational structure, delivery process and content are clearly important aspects of quality assurance activity. This section explores some of these ideas in the context of teaching and learning processes and activities in computing. Focus on this dimension of educational quality has been increasingly popular among accreditation bodies and tertiary education administrators, at least in the area of engineering and computing.

CDIO (Beggeren et al. 2003) adopts a broad model based on supporting students to Conceive, Design, Implement and Operate (CDIO) complex systems. The objectives as stated by Berggren (Beggeren et al. 2003) are as follows.

> "Three overall goals direct the alliance's endeavours. They are to educate students to:
>
> - Master a deep working knowledge of technical fundamentals.
> - Lead in the creation and operation of new products and systems.
> - Understand the importance and strategic value of their future research work."

The CDIO approach to quality deals with specifying and analyzing the content of courses and degree programmes with respect to specific and general learning outcomes. CDIO course and programme matrices specify the nature of individual courses and their relationship to, and role within, the degree programme as a whole. Each matrix lists all CDIO syllabus items in one dimension and marks them with

one or more of the values "Introduce" (I), "Teach" (T) and "Utilize" (U) (Gunnarsson et al. 2007).

The detailed nature of the production engineering style documentation that CDIO embraces also allows adopters to propose production quality metrics. Using production metrics drawn from the production process description, CDIO can implement a type of TQM that will be familiar to many practicing engineers. The Swedish Government approach to using CDIO for quality assurance of engineering education is described by Malmqvist and Sadurskis (Malmqvist & Sadurskis 2009).

National and international accreditation bodies also play an important role. In the U.S., ABET accreditation focuses on the structure and outcomes, as well as the content of engineering programmes. ABET provides very detailed guidelines on the structure, content and assessment practices which are required in order for a degree to be accredited. Similar bodies exist in many other countries. These initiatives have a significant effect on how education programmes are structured and taught.

In the U.K., the British Computer Society accredits both degree programmes and individuals as does the Australian Computer Society in Australia. Quality organisations in the European Higher Education Area are coordinated centrally by the European Association for Quality Assurance in Higher Education (ENQA). EHEA member states are required to have or create quality assurance agencies, which in turn are required to join ENQA. These agencies are charged to conduct regular external assurance audits at the program or institutional level. Program-specific accreditation is handled differently in different countries. In Germany, all university programmes are required to be accredited by discipline-based organizations. For example, ASIIN (http://www.asiin.de/english/newdesign/-index_ex5.html) accredits programmes in engineering, informatics, natural sciences and mathematics. In 2009, a Europe-wide network of computing accreditation organizations, called Eqanie, was established. Its goal is to ratify European standards for Bachelor's and Master's programmes in computing.

In Sweden, curricula and degree structures, as well as overall quality assessment, are managed by the university and subject to the Swedish Higher Education Act and Ordinances. Regular evaluation of universities is conducted by the Swedish ministry for higher education to ensure that universities meet the required standards.

2.2 Service

Product-centric quality management is one approach to defining structures and processes to deliver quality education. Another major area of activity associated with assessment of educational quality is evaluation of student perceptions of the quality and value of their education experience at University. These studies develop survey instruments working from a fundamental assumption that education is a product and that students are consumers/customers.

When dealing with perception and profit relationships in service markets, Buzzell and Gale (Buzzell & Gale 1987) concluded that customer perception is a primary factor when defining service quality. This argument is developed further by Soutar (Soutar & McNeil 1996) as follows.

> "Following in this vein, Hittman (HITTMAN 1993) is highly critical of the traditional approach to quality assessment in tertiary institutions. He suggests that the approach has been too narrow, with an over-emphasis on the quality of academics and too little attention paid to the non-academic aspects of the educational experience. He believes that quality in a tertiary education context is about much more than pedagogy. It would seem that measurements of student satisfaction must be holistic."

While an holistic approach is almost certainly desirable, current student-survey based approaches to evaluation of educational quality, in which aspects of learning outcomes and student development figure at best marginally, can hardly be claimed to be holistic in nature. In addition, there does not seem to be much real support for a claim that prior approaches measured aspects of pedagogy to any significant extent.

The objectives of a customer-focused approach to TQM are also emphasised by Soutar, and he re-emphasises the, then dominant, role of academics in defining performance indicators. No specific indicators are mentioned by Soutar, but the following quote illustrates his position.

> "One way to attain this quality mind-set is to develop an understanding in the employee group that TQM is concerned with meeting customers requirements. However, there is a tendency for the performance indicators to be written from the perspective of the educator. There has been little attempt to approach this topic from the point of view of the student."

There are several aspects of this argument that might cause educators some concern. Students' ability to evaluate a number of crucial aspects of educational quality is likely to be uncertain. Students are generally neither experts in the topic area being studied, nor expert educators, when they are taking undergraduate courses. Consequently, their judgments regarding the appropriateness of the instruction in terms of their learning development are often not well supported by relevant expertise. Student perceptions of what is taught and examined, especially for verbal approaches to continuous assessment, and other assessment methods which are not based on the evaluation of artifacts such as assignments or written examinations, can be misleading, both for students and academic administration if too great a reliance is placed on course evaluation surveys completed by students (Berglund et al. 2009).

Customer service surveys targeting student perceptions of education quality in the tertiary education domain have been investigated in a number of studies. Abdullah (Abdullah 2006) investigates two of the major higher education quality instruments, SERVPERF, and HEdPERF and derives a combined scale. During the evaluation reliability measures were computed and reported as follows.

> "The Cronbach's α for HEdPERF dimensions ranged from 0.81 to 0.92, with the exception of the dimension understanding (a 0.63). Owing to its low reliability score, the dimension understanding was removed as part of the scale modication process.

It might be argued that the low reliability on the "understanding" scale is linked to poor reliability of student perceptions of their own learning gains, and understanding of the pedagogy used in the instructional design in the courses and programmes under evaluation.
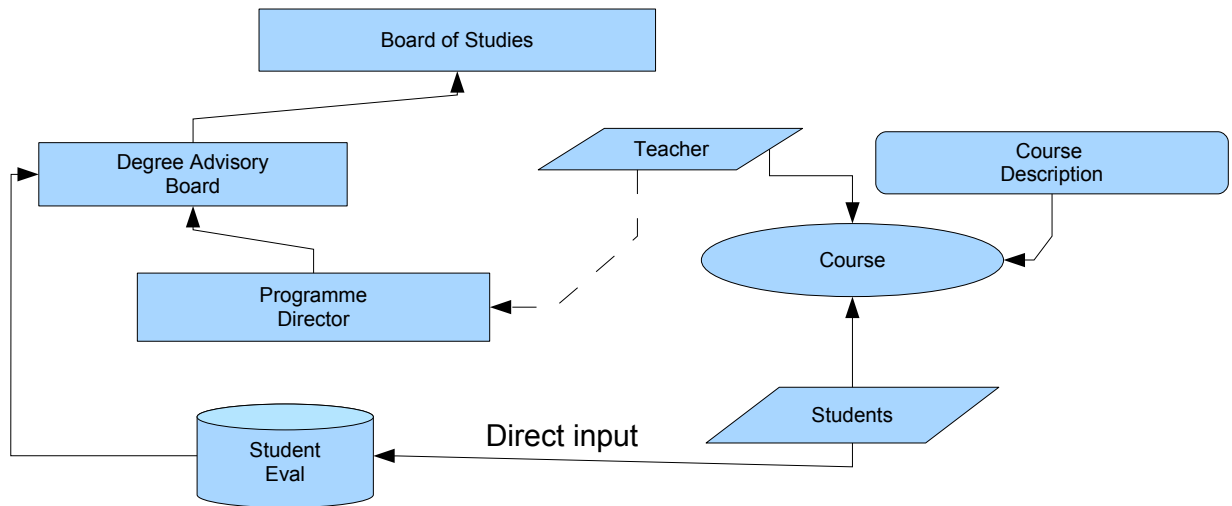
Figure 1: Quality Assurance Process

Finally, as Soutar observes, success in quality assurance ultimately depends on the credibility of the QA system.

> "... quality assurance programmes are essentially doomed if the service delivery people lack a belief in quality and are not imbued with a philosophy of quality."

In the context of QA in higher education, this implies that course and degree programme quality assurance processes must have credibility in the eyes of academics in order to be truly successful.

3   Development

The final view of educational activity we consider in this paper is of education as development. Here, the focus is on the student: helping each student to grow, realise their potential and contribute in a wider social context. This view can be related to the perceptions of university computing educators in regard to teaching and learning. These perceptions have also been characterised by a number of research studies (Berglund et al. 2009, Lister et al. 2007, Sheard & Carbone 2007).

Much of the literature in developing more student-centric approaches to learning and assessment in computing imply a developmental view of the educational practice at universities. However, several studies observe that there are indications that academics do not embrace new teaching methods with enthusiasm. Sheard attributes this to an inherent conservatism in the computing academic community (Sheard & Carbone 2007, pp. 2).

> "The higher education sector is still bound by traditional values and expectations. As Entwistle, Skinner, Entwistle and Orr (2000) argue, the pedagogies that academics adopt are strongly influenced by their own experiences as students."

Pears et al. (Berglund et al. 2009, Pears et al. 2007) argue that teacher beliefs about the nature of student success and difficulty in computing might limit their range of pedagogical responses.

University lecturers are recognised, and often internationally renowned, experts in their discipline areas. The technical content of the courses they teach is often closely aligned with their research. While teaching excellence has become increasingly important over the last few decades, the impact of this on academic classroom practice is limited and many courses are still taught in a traditional manner.

The Bologna process in the EHEA has provided participating computing departments with a motivation to revisit the scholarly foundations of degrees and the instructional design of courses. These aspects of courses are often not documented, even in the CDIO and ABET approaches, since these frameworks focus on content and delivery methods, not on underlying philosophy and teaching and learning theory. Viewing the role of education as helping individual students to develop their potential, focuses on the student, and simultaneously recognises the role of academic mentorship in guiding and developing potential in collaboration with the student.

Clearly a developmental view of higher education implies a need for greater academic involvement. High levels of integrity, collegiality and empowerment among computing academics need to be fostered, and appreciated to a greater extent. Another aspect of academic teaching which is crucial to success is to recognise that teaching methods in computing are highly individual, and related to course level, teaching philosophy and style. Micro-management of the fragile educational ecology can be detrimental to the quality of the education students receive.

4   Discussion

The previous sections have provided an overview of a range of aspects related to the quality of tertiary education in computing. Figure 1 presents a conceptualisation of a common approach to quality assurance roles and information flows for degree programmes, where the focus is on individual course quality assessment.

Internal quality evaluation, however, relies on assessments made by degree program coordinators. The advisory boards also rely heavily on student input collected using online surveys, and direct input from student representatives for degrees and courses. Student course evaluation questionnaires are collected for most courses, but the response rates for these surveys are typically low. There are several risks associated
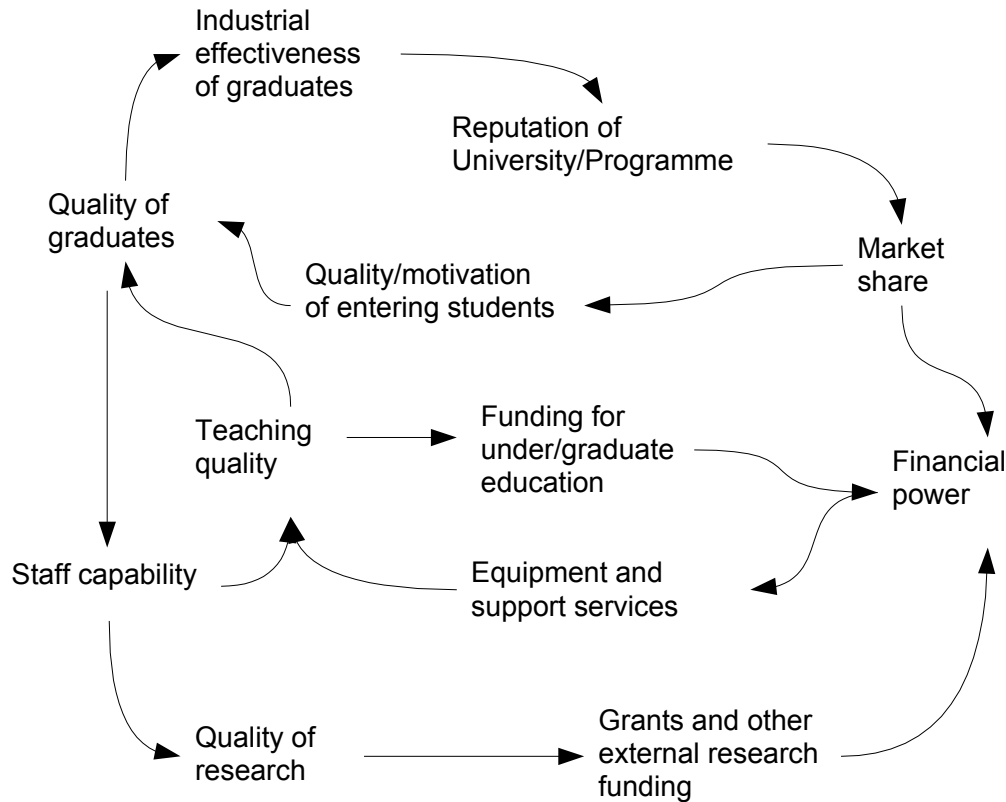
Figure 2: An Holistic View of Educational Quality

with using the data collected in such surveys as a direct measure of course quality. Low response rates make the statistical value of the data low. The surveys themselves are often untested in terms of reliability and validity. There are few surveys, of which the author is aware, that have been constructed to reveal underlying perceptions of service constructs, such as those proposed in SERVPERF and other similar instruments. If we are to continue to rely on student survey data in quality assurance activity, more attention needs to be paid to issues of what we wish to measure, and the validity and reliability of the surveys that we employ.

Even when reliable QA instruments are developed, it seems likely that more than one instrument will be needed. One key question that emerges is, who is the customer or consumer of a computing education? If the sole consumer were the student, then perhaps student perceptions are the appropriate way to evaluate quality. However, there are a number of other potential customers; employers and society seem plausible candidates.

However, it seems intuitive that educational quality depends on more than student perceptions. While customers may know what they want, likening students to other consumer segments is not necessarily appropriate. Learning theories dealing with concept and knowledge acquisition (Entwistle 2007, Meyer & R.Land 2005, Özdemir & Clark 2007) describe aspects of the process of acquiring new knowledge and competencies as placing learners under stress. This type of uncomfortable experience, though ultimately rewarding, may not be viewed with unequivocal approbation by the student engaging in the process.

Trust in academic systems can also be argued to be a vital component of creating a successful learning experience. It is not clear that learners are always adept at assessing the relevance and scope of their own learning gains while undertaking a course, or directly after its completion. These are the points at which we traditionally survey student opinions. Additionally, innovative teaching and learning approaches may be in conflict with students' conceptions of what "good teaching" is, and this can have serious effects on how students evaluate non-traditional educational approaches.

Employers can also be considered the customer with respect to University product. In this role, they also have a part to play in evaluating the quality of the outcomes of the production process. What metrics are appropriate in this domain? Graduate employability? Employer satisfaction?

Society also has expectations of the outcome of education. This is particularly apparent in disciplines such as computing and branches of engineering, where the failure of newly appointed university graduates to perform tasks competently and ethically might be attributed to poor educational quality. The ultimate implications of poor quality in this definition are systems that fail with consequent financial implications and perhaps loss of life.

Finally, academics themselves have a significant stake in the quality of the knowledge and competencies instilled in students during their studies at university.

Figure 2 gives an holistic model of factors related to educational quality adapted and extended from Owlia and Aspinwall (Owlia & Aspinwall 1997). A quality framework incorporating many of these aspects has also been proposed by Owlia and Aspinwall (Owlia & Aspinwall 1996). The integration of these factors into a multi-faceted QA survey instrument, or several QA instruments targeting different

stake-holder segments, would help to improve the internal credibility of QA activities.

5 Conclusions

This paper discusses three perspectives on quality of computing education. Treating education as a production process, with standards and process descriptions designed to produce certain guaranteed outcomes has been discussed in the light of accreditation efforts, and standardisation of education in the US, Europe and Australasia. While there are advantages to this type of approach in terms of making explicit the aims and processes involved in educating undergraduates, there is also a risk that such approaches become overly prescriptive. An overly prescriptive approach can result in QA processes that attempt to deny the variability of experience, learning styles, and learning goals and educational approaches, intrinsic to the complex socio-cultural system embodied in a seat of higher learning.

We argue that treating education as a service, and identifying the student as a customer, or primary consumer, of an educational service, can be highly detrimental to educational quality. We challenge the assumption that the view of the student as customer is appropriate in modelling higher education service. Alternative definitions of the customer as either society, or employer groups, produces a very different view of what appropriate quality metrics might be, and how they should be assessed. We also argue that the role of academics as experts and valuable internal stake-holders in the delivery of quality education deserves greater recognition. Academic teachers embody expertise in the academic disciplines at the core of university education. Their role and opinions in achieving quality education deserve greater weight.

Finally, an assessment of the current practices and instruments used in typical QA processes at universities show a number of shortcomings. Survey instrument validation and reliability is questionable, and this places the value of the entire exercise in doubt. Academic stake-holders increasingly perceive these instruments as a threat, and fall back on traditional teaching models as more easily defensible in the prevailing QA climate. We identify aspects of a more holistic model of educational quality for universities, and urge computing departments to draw on the established literature to construct reliable and valid student QA survey instruments, while at the same time broadening the the scope of QA activities to embrace all of the themes mentioned in this paper.

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