

Enhancing Engineering Programs Through a Quality Assurance Review Process

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This paper discusses how faculty members can work together to engineer program outcomes by engaging in a quality assurance review process. A variety of program planning methods exist in higher education and are used to design and construct engineering programs. Engineering educators naturally wish to develop quality programs that are distinctive and reputable. Program enhancement occurs when academics are able to reach a common understanding of the nature of a 'quality' engineering program, use certain principles, and choose a strategy that meets faculty needs. The goal of a quality assurance process is to subject the educators' theory and practice, as well as students' program outcomes, to critical reflection. Quality programs are the result of a faculty having quality control processes and continuous quality improvement mechanisms.

INTRODUCTION

We know remarkably little about the ways in which teachers plan their courses, monitor their progressive development and review their effectiveness [1].

QUALITY assurance is the sum of activity where stakeholders are assured of a level of quality and its continued improvement. This is a four-stage process. First, participants collect evidence to make observations about theory and practice. Second, they reflect on past teaching and learning experiences, the program's intended and unintended outcomes, and assess management control processes. This thinking is then used to encourage planning,

make recommendations to improve that quality of programs, and to suggest controls and indicators that guarantee it is achieved. Finally, they implement the plans. This spiral (observe practice, reflect, plan, act) can be used in a cycle of assurance review activity (Figure 1).

We may know little about higher education teachers' use of effectiveness review processes. But we know less about quality assurance processes in engineering education. This paper attempts to address that gap and discuss why and how faculties can assure program changes that aim to engineer quality outcomes.

I shall argue that a variety of program planning methods exist in higher education with the assumption that planning activity will produce a 'quality'

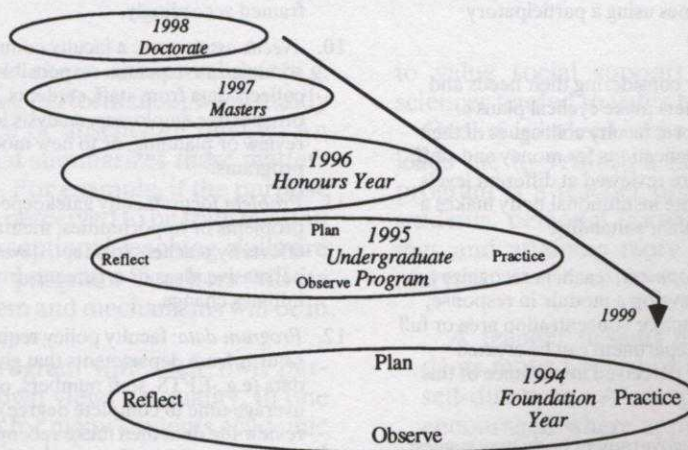


Fig. 1. An example of a five-year quality review cycle in a British-based system.

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engineering program. This is not necessarily the case without an assurance review process.

CURRENT PLANNING PRACTICES IN ENGINEERING EDUCATION

There are two ways to analyze different institutional practices of academic program planning and module design [2]. The first focuses on people whereas the second focuses on mechanisms (Table 1). They appear distinct but, with the press of time, in practice they can often become blurred. Which one(s) exists in a faculty is a function of management style, whether the focus is undergraduate or postgraduate education, the perceived current needs of the university's or faculty's mission, or pressures from the institutional context. Various practices may exist simultaneously in different departments within the same faculty.

Regardless of such factors, do they produce 'quality' programs? A major difficulty is to determine what a quality program or module is perceived to be [3].

CONFLICTING IDEAS ON QUALITY PROGRAMS

In Table 2 I propose four common conflicting conceptions of program or module quality [4]. In each case quality is assessed by focusing on the teacher's plan, its implementation, outcomes or implications. Table 3 indicates that the origin and emphasis of each idea is different. Each choice has a different focus from the teacher's perspective. Quality is concerned with inputs (resources, staff, students), processes, or outcomes (adding 'value' to students by arming them with more sophisticated knowledge and understanding as well as skills, or providing for staff research). Groups or individuals often focus on one and relegate the others to a subsidiary role. For example, the first two conceptions focus on inputs and the last two on process.

It seems that 'quality' is like 'beauty', 'love' or 'truth'. It is merely an ideal state rather than 'real'. It is not absolute and therefore difficult, if not impossible, to quantify. What colleagues or management believe it to be depends on individual or group values which determine the way it is

Table 1. Academic program planning practices-84

<i>Practices Principally Based on Participants</i>	<i>Practices Principally Based on Mechanisms</i>
1. <i>Administrative</i> : the dean or vice-dean seizes on an idea, forms a working party to fill out the structure and details, then gives advice on how to implement it.	7. <i>Budgeting</i> : the availability of funds determines which modules or programs will receive continued or increased support, or which may be downsized or terminated.
2. <i>Entrepreneurial</i> : individual teachers, as professionals, propose modules when and as they see fit; the faculty leaves program modifications and change strictly up to the teachers.	8. <i>Development fund</i> : the faculty budgets a certain amount of money that is up for competitive bids by teachers who have an idea for module development, then a committee considers if it has merit.
3. <i>Curriculum committee</i> : the faculty forms a committee composed of representative groups (e.g., administrators, teachers, or students); members review existing programs or proposed changes or new ones using a participatory consultative style.	9. <i>Economics</i> : academic managers see the faculty in terms of an economic unit where members respond to incentives like rewards for reducing costs or maximizing outputs, then policies are framed accordingly.
4. <i>Democratic</i> : after considering their needs and self-interest teachers make cyclical plans at intervals then inform faculty colleagues of their intentions and implications for money and staff; these proposals are reviewed at different levels until an appropriate institutional body makes a final decision on their suitability.	10. <i>Needs assessment</i> : a faculty committee or administrative person responsible for the task collects data from staff, students, alumni and prospective employers; analysis leads to program review or planning, or to new modules or programs.
5. <i>Knowledge development</i> : teachers recognize new knowledge and develop a module in response; this can lead to a major concentration area or full program; a new department can be created depending on the perceived importance of this knowledge.	11. <i>Problem focus</i> : faculty gatekeepers perceive problems or opportunities; their analysis leads to efforts by teachers to adapt, develop or change; persuasive ideas or arguments from any source initiates change.
6. <i>Outside bodies</i> : a government body may suggest or impose a process upon faculty planners in addition to normal institutional ones; these bodies collect data, analyze them, then take planning initiatives on the basis of political decisions which eventually effect the faculty.	12. <i>Program data</i> : faculty policy requires annual returns from departments that give comparable data (e.g., EFTS, staff numbers, operating costs, average time to complete degree); administrators review the data then make recommendations and negotiate or force changes.
	13. <i>Program review</i> : specially appointed staff review the module or program quality and its strengths and weaknesses from many perspectives; recommendations are made and change is left to decision makers.

Table 2. Common conceptions of a quality program or module

1. *Quality Program as Consistently Satisfactory Teaching Performance*
A teacher engages in accepted interactive processes to teach defined content. These processes help satisfy his/her supervisors' specified high standards and informal expectations. A quality teacher does not experiment with his/her students' learning by adopting untested or uncommon strategies. Instead there is a satisfactory, if not excellent, performance of standard delivery methods that result in a 'quality' program with 'good' results.
2. *Quality Program as Efficiently Managed Cost Effective Teaching in Programs/Modules*
A teacher provides a service at a 'price' that the market will bear and meets defined performance indicators that ensure everyone's satisfaction. A quality teacher is recognized by prospective students and his/her classes are often over-subscribed. Students spend an inordinate amount of time on the work in the module as they believe it will benefit them most. Administrators support the module and program with more staff, money and a higher profile because it is obviously valued, cost effective, and efficiently run.
3. *Quality Program as Appropriate Teaching Actions to Fulfill Training Goals*
A teacher's behavior advances the department's and faculty's mission to fulfill their training obligations to students whom they see as clients. The teacher's actions may include commonly accepted strategies or innovative approaches, as appropriate, in light of needs and circumstances. Whatever methods are used, positive student feedback on the quality of their learning is the best evidence of a 'quality' program. Supervisors pay keen attention to student appraisals to ensure students perceive their personal needs are met by program teachers.
4. *Quality Program as Exceptional Teaching Performance*
A teacher offers an exceptional service in the performance of teaching duties. His/her plans and actions are distinctive and exceed expected common standards met by peers. A quality teacher is known by his/her ability to command respect and is held as a model for others. A quality teacher has a reputation as a 'high-flyer' from whom colleagues and students seek advice. Exceptional performance is underpinned by anecdotal feedback and supportive student appraisals. A teacher's reputation is reinforced and enhanced by exceptional public displays that are also praised by peers.

Table 3. The origin, emphasis and focus of each quality conception

'Quality' Conception	Primary Emphasis	Primary Origin/Focus
Quality programs or modules as:		In relation to the teacher:
1. consistently satisfactory teaching performance	<ul style="list-style-type: none"> • recognized and acceptable delivery methods 	<ul style="list-style-type: none"> • external origin – administration • focus on teacher behavior
2. appropriate actions to fulfill training goals	<ul style="list-style-type: none"> • desire to achieve chosen goals 	<ul style="list-style-type: none"> • external origin – administration • focus on teacher behavior
3. efficiently managed cost effective programs and modules	<ul style="list-style-type: none"> • efficiency and effectiveness 	<ul style="list-style-type: none"> • external – administration • focus on teacher management
4. exceptional teaching performance	<ul style="list-style-type: none"> • teacher, teaching, personal drive and natural competition 	<ul style="list-style-type: none"> • internal – teacher • focus on teacher behavior
5. opportunities for students' personal transformation as engineering learners and doers	<ul style="list-style-type: none"> • learner, learning and teacher-learner cooperation 	<ul style="list-style-type: none"> • internal – teacher • focus on learner behavior and outcomes that are fit for a professional engineering context

conceptualized. If we share those values (e.g. efficiency, effectiveness, performance) we instantly recognize the presence or absence of quality. An encompassing view that summarizes these matters is 'fitness for purpose'. For example, if the purpose of a quality program is perceived to be transmission of knowledge, then exceptional teaching skills are the basis of a quality program. Teachers will be persuaded to attain them and mechanisms will be in place to support this view.

Students enter a program with their own purposes and have their own views on quality. In one study it was found that for many students academic satisfaction lies in stimulating course work and helpful teaching [5]. These are more important factors than social support such as opportunities for student-teacher interaction or perceived teacher knowledgability. However, there were gender and discipline differences. Women tended

to value social support and students in 'hard' sciences tended to value teacher knowledgability.

Quality is indeed in the eye of the beholder. This leads me to venture a fifth conception: a quality program is a teacher providing opportunities for students' personal transformation of understandings and attaining more complex skills. In summary:

A teacher designs the program to help students move toward or attain independence and self-direction. A deep learning approach is encouraged where appropriate. Learners tackle core modules and electives with relevant content that is interesting and personally meaningful. Students are helped to experience a personal transformation of their ideas, mental structures, behavior and personal standards as a professional. Supervisors and students readily recog-

nize quality teaching by students' high level of interest and participation. The excellence of student contributions and outcomes, as a result of the teacher 'adding value', enhances a quality teacher's reputation.

Quality programs or modules seen as opportunities for personal transformation emphasize learners as doers. They focus on learning and teacher-learner cooperation to strive for understanding and practical outcomes.

This conception opposes those previously proposed. The emphasis is the student and learning outcomes. It is also on the teacher facilitating learning. In a faculty debates occur because staff have various conceptions as personal theories and influential groupings can be formed. Changing the emphasis and focus of a quality program from the teacher to the learner will be a radical suggestion in some quarters and will meet resistance.

In practice a 'quality engineering program' or module is what a faculty's administrators say it is! In the absence of research, faculty self-study or a searching self-reflection, their view is also based on their personal theory derived from experience. Why should engineering educators consider rising to the challenge to move from one of the common conceptions to a more student-centered view? Simply put, the answer is to enhance professionalism and assure quality in line with current understandings of higher education learning and teaching [6].

Is there a framework that can help?

SCRASP MODEL OF PROFESSIONAL ENHANCEMENT AND QUALITY ASSURANCE

Table 4 shows the SCRASP model, which is a framework for faculty quality enhancement efforts

[7]. It suggests that in a supportive context that welcomes suggestions for improvement, engineering educators are bound to improve the quality of their programs and outcomes. This outcome can be achieved by applying their naturally critical attitudes and conducting research into their own teaching and students' learning, supported by external assessors. There are intrinsic and extrinsic reasons. First, educators will do this because they are accountable to various stakeholders within and outside the university. Second, perhaps due to pressures from management, a personal drive to become better professionals is incubated.

Therefore by applying self-evaluation and critical self-reflection these imperatives can be met based on certain principles.

QUALITY ASSURANCE PRINCIPLES

Four principles are the foundation of any review focus or decisions. If these principles are congruent with a faculty's management style they can help change planning, design or implementation practices [2, pp. 318-321]:

1. *Constructing a conducive environment supported by authorities:* deans and heads of department must create or enhance the decision making environment for staff; emphasize regular cycles of planning and reviewing activities that are routine, cyclical and expected; and indicate to their colleagues that they value these activities and consider active involvement an important part of scholarly work;
2. *Requiring high staff participation levels:* as staff teach and administer modules and programs their experience is invaluable and can be harnessed in the process; involvement increases the likelihood of effective change

Table 4. The SCRASP model as a framework for quality enhancement efforts

S	<ul style="list-style-type: none"> • <i>Supportive contexts</i> where academics uses their 	<ul style="list-style-type: none"> • developing a desire to found or enhance quality programs and modules that focus on opportunities for student learning and personal transformations;
C	<ul style="list-style-type: none"> • <i>critical attitude</i> and apply it to 	<ul style="list-style-type: none"> • critiquing the status quo concerning ideas and practices in the context (e.g., SWOTIN analysis);
R	<ul style="list-style-type: none"> • <i>research into teaching & learning</i> to satisfy the need for 	<ul style="list-style-type: none"> • identifying strengths, weaknesses, opportunities, threats, interests and needs in the faculty's program, in the light of pertaining and expected circumstances, and offering optional directions using a spiral of action research cycles (practicing – observing effects and outcomes – reflecting and judging – planning quality change and improvement);
A	<ul style="list-style-type: none"> • <i>accountability</i> to stakeholders by using 	<ul style="list-style-type: none"> • assessing the academic, professional and community value of current strategies and practices and justifying proposed changes;
S	<ul style="list-style-type: none"> • <i>self-evaluation</i> at individual and group level to enhance 	<ul style="list-style-type: none"> • self-reflection and self-evaluation as part of teachers' research into their own teaching, and systematic review processes, e.g., by inviting past and present students and others to provide critical observations and evidence; in order to strive to enhance program distinctiveness, reputation and quality;
P	<ul style="list-style-type: none"> • <i>professionalism</i> of teachers and the faculty 	<ul style="list-style-type: none"> • professional development of faculty staff through action research where they are able to participate in review processes; and professionalism as university teachers and scholars by addressing the above five requirements.

and improvement because of a feeling of ownership; a central feature is managing review participation to arrive at thoughtful and timely decisions that will lead to quality outcomes;

3. *linking program plans to resources and the faculty strategic plan*: recommendations must be based on decisions about faculty values and priorities and also take account of available resources over different time frames; and the faculty strategic plan and goals should provide the framework for making improvement recommendations (e.g. 3 or 5 year plan); and
4. *Documenting planning decisions and the process*: preparing a reference document that includes a rationale for program review and/or change and the expected outcomes; but most importantly, making it an action plan with recommendations that can be used by interested parties (e.g. administration, external examiners/reviewers).

Having a satisfactory framework or high-sounding principles are one thing. But how are they operationalized?

REVIEW STRATEGIES TO ASSURE QUALITY PROGRAMS

These principles are put into action by focusing on any one of five review strategies which focus on the following [8]:

- program inputs (current levels, expected levels, real needs to improve quality);
- program outputs (learning and teaching outcomes and their effects), or objective attainment (meeting stated objectives and assessing if they are adequate in the face of changing times), or a goal-free review (focusing on what really happens and concentrating on actual outcomes regardless of intended goals);
- program processes (what is done, why, how and with what level of success or quality measured in various ways);
- a comprehensive self-study of all the above (task forces with independent focuses that are coordinated and integrated into a report and action plan); or
- assuring quality by relying on external judges, e.g., qualitative judgements provided by an external examiner on any of the first three strategies, or judgements on the claims of a self-study (necessarily brief due to his/her other duties); or, alternatively, by hiring an external reviewer to assess these matters in greater depth over an extended time.

The function of academic leadership in the quality enhancement process is to mobilize people to submit to a review of their theory and practice. The choice of internal or external assurance

mechanisms can be a matter of debate or dictated by university policy.

What issues need to be addressed in order to improve program quality?

ISSUES THAT DRIVE PROGRAM QUALITY IMPROVEMENT

The questions for those who wish to engineer quality in a faculty by building in a review process are [9, 10]: what are the goals and expected outcomes of review and improvement; what are the costs and benefits among process alternatives; and how can we decide among alternatives? Answering such questions to improve programs means thinking about people, goals, processes and outcomes [8, p. 434].

- *Choosing the right people*: putting a working party together composed of thinkers and doers who are also opinion leaders and can persuade others to get things done; and involving staff by using a review process with goals that are well known and widely supported;
- *Defining a quality program and achievable goals*: proposing a rationale about improving quality programs within a faculty; defining a quality program and its indicators for the context; identifying formative or summative evaluation goals; and defining whether the audience for your final report is internal or external to the faculty or both;
- *Designing a suitable process*: understanding that program improvement recommendations and actions are part of a process to specify, define, collect, analyze and interpret quantitative and qualitative information; using a process like action learning to construct options based on wide public consultation and suitable models elsewhere [11]; understanding that many people within the faculty and outside need to be involved and heard so they can influence the direction and content of suggested changes; and
- *Recommending suitable outcomes*: analyzing and evaluating, making judgements among them, e.g. whether to initiate, continue, modify, expand or terminate a module or program, or support teaching or learning in some new or different form to attain higher levels of quality.

The ultimate goal is either to put quality control processes and continuous quality improvement mechanisms into place, or enhance those that exist through rigorous faculty scrutiny.

PERSONAL REFLECTION

Earlier I suggested that quality is like 'love', or 'truth' in that it is determined by individual or group values. I shall now reflect on my view as an outsider asked to provide occasional input into engineering education discussions.

The only things I have to act on are my learning, values, and experience. These find me in opposition to my perceptions of currently popular views of engineering education. Generalizing, I see them based on content rather than specified objectives and driven by summative assessment rather than formative or diagnostic assessment. I see them focusing on teaching as transmission rather than teaching as facilitating learning through problem solving or experiential learning.

I believe that a quality engineering program has specified relevant and comprehensive professional learning outcomes (attitudes and values, knowledge and understanding, skills and practices) valued by a faculty, its professional reference group and employers. A quality program focuses on how teachers can best facilitate their students' learning. It focuses on learners and their interests as active learners. It ensures students' competence as junior practitioners beginning a career, or enhances practitioners' professionalism by providing continuing education. It promotes autonomous learning over the period of a degree, structured problem solving depending on the learner's experience, and opportunities for realistic critical self-reflection as a professional. Engineering educators concerned with quality focus on preparing professionals for the demands of practice by infusing relevant experience into their program as much as possible [12].

This view is not new. I suggest that McMaster University in Canada is a good example where problem-based professional education has been deeply rooted now for two decades. Their chemical engineering and medical education approaches are particularly noteworthy and are used as examples by other universities. In England a new emphasis on active student learning and problem solving in a professional practice context is changing chemical and mechanical engineering education [13, 14].

In part, whether a program possesses quality program is a question about the nature of its validity, merit or worth. A *valid* program that fulfils learners' needs may not be a quality program because of deficits in other areas. Similarly, a program may have *merit* because it is taught well and is well received by learners. But this same program may not have *worth* for professionals in the field because it lacks a practical emphasis. Whether a program must be valid, have merit and be worthy simultaneously to have quality are issues for debate. Opinions will vary due to personal and departmental values. Any interpretation of quality will depend on the context and who the participants are. These are political issues and one can expect to hear a great deal of rhetoric as participants' quality program theories collide and their assumptions are challenged and reluctantly transformed. It is a tense process to identify legitimate observations from practice, submit conflicting theory and research to scrutiny, then come to

agreement about reasonable improvement solutions [12].

Program change aimed at making student learning and learning outcomes the principle indicators of quality is an interesting academic issue [15]. The chief questions for engineering educators are: *what are the current learning approaches students use; what are the current teaching and assessment methods adopted that influence these approaches; and what value-added outcomes do you wish to see and why?* A review normally begins from what is happening in practice then proceeds to what the faculty values and desires. These are issues and questions where passion is the first product of the collision of theories-in-practice. Establishing a routine cycle of reviews with different participants investigating quality program issues at different times is a good beginning [12]. Passions may be more controllable with experience!

In the US a passion for engineering teaching may not be closely related to compensation however [16]:

That teaching is not rewarded has ramifications for the attrition of students from engineering: recent research shows that lack of interest in teaching on the part of engineering faculty is a factor in the decision of undergraduate students to switch out of an engineering major. Until academic leaders and their faculty decide to place a higher value on teaching and instruction, it is unlikely that external efforts to enhance undergraduate engineering education ... will result in lasting change.

Consideration of a quality assurance review process will focus staff attention on student learning outcomes, problems associated with their programs-in-action, and their need to value the teaching role more highly to achieve quality programs. It is one step toward important quality-focused change.

CONCLUSION

Quality programs are not necessarily the result of current planning practices. There are conflicting views on what quality is in any case. Reviewers concerned with quality issues will be helped by a quality assurance framework like SCRASP, specified change principles, and by using defined review strategies. Having built-in review process to assure quality will promote administrators' and teachers' confidence in program outcomes. It will also assist the enhancement of program distinctiveness and reputation. By adopting a student-centered view and engaging in continuous quality improvement activities, teachers are best able to help graduates gain practical knowledge and understanding, relevant skills, and ultimately more satisfaction in the workplace.

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