QUALITY IN HIGHER EDUCATION

* Prof. John J. Sparkes

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ABSTRACT

Quality in higher education can be defined as a matter of 'specifying worthwhile learning goals and enabling students to achieve them'. With this as their aim, it is first necessary for teachers to distinguish between different kinds of learning and to know what to do to help students achieve their learning goals and, secondly, to distinguish between students different preferred learning styles and to accommodate them. This paper explains and illustrates how these things can be done.

1. INTRODUCTION :

In April 1992 Roger Roxby[1] published an article in this journal entitled 'Quality in Education'. It was an overview by an industrialist of what engineering education should be like. It distinguished between four aspects of the process, namely 'administrative functions, deliverable, delivery and deliverers (the 3Ds). Having beeen in the electronics industry for 10 years myself, I can recognize this kind of analysis, but having also been in university teaching for many years I can now recognize it as too simplistic. For example, the whole article is about what teachers should do in order to turn out a 'product' which needs little further training in industry. It is true that he also says[2] that one can 'consider delivery in terms of a learning process instead of a teaching process and understand how students, individually and as a group, best learn a subject rather than how a faculty can best teach it', but he does not persue this important idea. This paper focuses quite specifically on 'how students learn' and on the implications of this knowledge on the meaning of 'quality' in higher education, with particular reference to engineering education.

Before analyzing the nature of quality and how to achieve it, it is important to be clear about the subject matter to be taught and learned, particularly where engineering in concerned. In design, which is one of the key activities of engineers, it is necessary, if quality is to be achieved, not only to bring technological principles (such as feedback, quality and production methods) to bear on the process, but also to apply other disciplines such as science, mathematics and value judgements as indicated in Fig. 1. A similar breadth of subject matter does not usually have to be included on courses in these other subjects.

* Ex Professor of Electronics, Open University, UK.

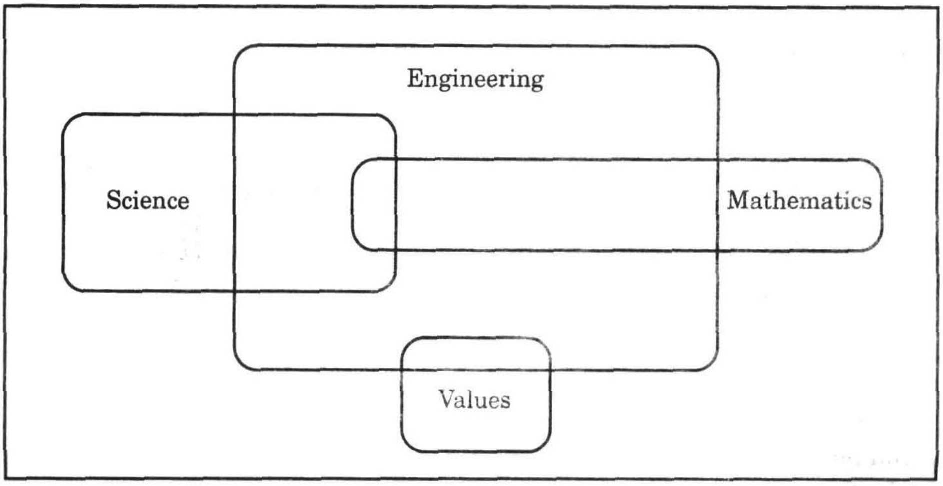

Fig. No. 1 : Venn Diagram Illustrating the Relationship between Engineering (or Technology) and other Fields of Study

QUALITY VERSUS QUALITY ASSURANCE :

It is often said that it is not possible to define quality in education, but that one can recognize it when one sees it. This is not really true. Defining quality is actually quite easy; achieving it is the problem ≫ "Quality is nowadays generally regarded as fitness for purpose" which can be translated in the field of higher education as a matter of :

'Specifying worthwhile learning goals, and enabling students to achieve them', where

- 'Specifying worthwhile learning goals' involves paying attention to academic standards, to the expectations of society, to students' aspirations, to the demands of employers, to the requirements of professional institutions, to the fundamental principles of the subject, etc. These are not all compatible, so there can be many valid interpretations of 'worthwhile'. It is necessary therefore to be clear about the intended aims. (Roxby's search for 'the customer' is simplistic even in his own environment, where products are matched to the needs of different kinds of customers.)
- 'Enabling students to achieve' these goals involves making use of research into how students learn and building on successful teaching experience.

'Quality is not, however, to be confused with 'quality assurance' (as Roxby does). The purpose of quality assurance (QA) is to ensure that people continue to do what they believe they should do, as best as they can, week in and week out, and to introduce improvements wherever they can. QA therefore consists of procedures which can be applied equally well to doing the wrong things as to doing the right ones. Edwards Deming[3], the guru of quality assurance in industry, summed up the situation with the words :

'Everyone doing their best is not the answer. They must first know what to do'.

Ensuring that everyone does their best is the business of *quality assurance;* everyone knowing, or better still understanding, 'what to do' is necessary if good quality is to be achieved, but in order to 'understand' 'what to do' it is essential that teachers distinguish between the different kinds of learning expected of students, so that they can match their teaching and assessment methods to whatever goals are specified. The point is that different kinds of learning require different teaching and assessment methods.

Regarding education as something which is 'delivered' to students, as Roxby does, is unsatisfactory because education is too complex a matter simply to be delivered. The best definition of good teaching is 'the creation of educational environments in which students can effectively achieve their learning goals'. This is much more than 'delivery' (e.g. in the form of lectures) since it can also involve various kinds of interaction with teachers, colleagues or computers, activity in laboratories, projects and so on. Professional teachers should be able to match the educational environments they create to the learning they expect to see taking place.

DIFFERENT KINDS OF LEARNING :

The first task, therefore, when aiming for quality in any given field, is to distinguish between different kinds of learning in such a way that they map well into different methods of teaching. It is not so much a matter of distinguishing between different subjects, because all subjects include most kinds of learining, it is more a matter of differentiating between different kinds of learning. Bloom's famous taxanomy[4] is inadequate because it distinguishes between different educational 'objectives', rather than between the different kinds of learning which enable people to achieve these 'objectives.' For example, although students 'understanding' can give rise to a variety of outcomes, the converse is not true. That is, once the expected outcomes have been specified, it is usually possible for students to meet these objectives without having understood very much. For example they can often answer exam questions intended to test their understanding by 'recalling' a model answer to similar question, or by using a well practised intellectual 'skill'.

The simple commonly used taxonomy in the cognitive domain, comprising 'knowledge', 'skills' and 'understanding', is satisfactory provided each term is well defined, and provided a fourth kind of learining, usually referred to as 'know-how', is added. Unfortunately these terms are, normally used very imprecisely and tend to cause confusion rather than clarification. Note that when scientists were faced with a similar problem, they solved it by giving words such as 'work', 'energy', 'force' and 'inertia' precise meanings for use in a scientific context but retaining their everyday meaning in normal discourse. The same strategy is being adopted here as regards learning terms used in an educational context. The following definitions of 'kinds of learning', together with indications of the appropriate teaching strategies, are here proposed.

LEARNING IN THE COGNITIVE DOMAIN :

Knowledge is 'information that has been memorized and can be recalled in answer to a question'. (It is taught by presenting information, or making it available, in a motivating way.)

A *skill* is defined as[5] 'a complex sequence of actions which has become so routinised through practice and experience that it is performed almost automatically'. Examples include walking and playing tennis, communication and interpersonal skills, using a computer, touch - typing, designing, applying mathematics, etc. Skills, unlike knowledge, cannot be learned instantaneously however interested the learners might be. Note that skills such as 'designing' may also involve the use of 'understanding', 'knowledge' or 'know-how'; it is the process itself which, like walking, can become a skill. (Skills are taught by instruction and demonstration and are learnt through practice with error correction when needed.)

Understanding is 'the capacity to use explanatory concepts creatively in problem-solving' : for example, in explanations of new phenomena, in new designs, in correcting unfamiliar errors and faults, in asking searching questions, in argument and discussion, and so on. It is the key to 'thinking' and to the ability to tackle new and unfamiliar problems successfully. Acquiring understanding consists of two parts :

(a) becoming familiar with the relevant explanatory concepts (e.g. energy, magnetism, productivity) upon which understanding depends.

(b) learning to apply them to tasks such as those listed in the definition.

(Understanding is taught by providing a 'rich educational environment', as explained in more detail in a moment.)

Know-how is 'a problem-solving capability, acquired through experience' rather than through gaining familiarity with explanatory concepts and their application (of understanding). Thus problem - solutions which depend on 'know-how' are extrapolations from previous solutions, whereas problem solutions which depend on 'understanding' are thought out from first principles and can be quite new. The intuitive and experimental elements in 'know-how', replace the analytical and theoretical elements characteristic of 'understanding', (Know-how is learnt through experience of successful problem-solving, such as that provided in apprenticeships)

Hence, by specifying learning goals in terms of what should be 'known', what 'skills' should be acquired, what principles should be 'understood' and what kinds of 'experiences' are relevant, it is possible to provide 'good quality teaching' in the sense that the methods adopted match the intended learning goals.

In engineering, a particularly improtant skill is that of 'integrative thinking'. Although this is a natural human capability, since we use it all the time in the conduct of our everyday lives, it is easy to let it lapse when scientific rather than common sense concepts are being used. As Wolpert[6] has pointed out, scientific concepts are not 'natural', and conflict with common sense, so practice in integrating them with other considerations is needed, as it is with any other skill.

The 'rich learning environment' referred to in connection with developing understanding is needed to achieve the difficult job of internalizing new concepts - such as 'force', 'inertia', 'magnetic flux', 'entropy' and 'feedback' - in students' minds and seeing how to apply them. So a rich learning environment must include teachers (or books) introducing and explaining the new concepts, putting them in context and illustrating how they can often predict outcomes better than common sense; and then ensuring that students read and write about them, discuss and argue about them, apply them in problem-solving exercises, explain them to fellow students, and so on. Whilst it is true that 'information' can be delivered to students, as Roxby suggests, the concepts on which new forms of understanding depend, can not be transferred so simply. The best that teachers can do is to help students internalize them, which is no different in principle from the early learning in childhood when the common sense concepts of 'table', 'red', friendliness', etc. are acquired through guided experience in a rich learning environment. The difference is that the new 'unnatural' concepts, which students of conceptually - rich subjects like science have to internalize, do not emerge from experience as do common - sense ones; they were only identified in the last few hundred years by geniuses, so they are unlikely to be recreated by students without help. These new concepts have, so to speak, to be laid alongside common sense ones, only to be used when appropriate. Too much adherence to sciendific concepts when common sense is more appropriate is one of the temptations of academia !

The importance of understanding in engineering can be illustrated by considering the process of innovation.

First note that innovation is more than creativity (in engineering at any rate.) Having a new idea is being creative, whereas innovation is the disciplined business of converting the idea into a successful product or system. The British have always, it seems, been very creative, but have all too often found that their competitiors are better at innovation.

There are three main ways of being innovative :

(a) One can implement the idea in what seems like a good way, and evaluate the outcome (e.g. by feedback or 'reflection'). This is innovation by trial and error and if one is lucky, one can succeed; but in practice it wastes time, energy and money and the error part can damage people for life.

(b) One can extrapolate from experience, which is still a bit chancy, but can be satisfactory as a means of innovation *within* current practice.

(c) One can implement the idea by understanding both the problem and the capabilities of different forms of implementation and by thinking out a solution. This is the only reliable form of innovation *beyond* current practice, and has to be used to design new artefacts such as new types of integrated circuits and space stations or systems such as Internet. So, for those heading for the top of their profession, 'understanding' is crucial.

Note particularly that problem - based learning[7] on its own, which has become very popular of late, does not usually lead to 'understanding'; it develops 'know-how'. Most students cannot be expected to induce successful explanatory concepts from experience, as Newton or Faraday did. So problems which require scientific or technological solutions must be preceded by an introduction and explication of the appropriate concepts, and the problem must be chosen to bring out the need for these new concepts. The experience of discovering, for example, that filling balloons with hot air can cause them to rise is the limit of validity of problem - based learning about hot air balloons. Attempts to understand what is happening can just as well lead to the 17th century idea of negative-mass phlogiston being given off by the burner and filling the balloon, as to the current more complicated explanation in terms of

'Archimedes' principle. Equally, the everyday experience of time passing slowly when one is absorbed does not naturally lead to the scientific ieda of the steady passage of time !

LEARNING IN THE AFFECTIVE DOMAIN :

Learning in the 'affective domain' is also important. Indeed the motivation to learn is crucial for all kinds of learning, so steps must be taken to rekindle students' natural desire to learn if it has been allowed to lapse. Also, in designing, attitudes and values play as important a part as aspects of the cognitive domain.

The terms which distinguish elements of the affective domain do not, however, need special definitions, since no new counter-intuitive concepts have been introduced to complicate matters, as has happened in science and technology.

Motivation is variously defined in dictionaries as 'the desire to do' or 'the drive to achieve' or, more precisely[8], 'the internal process that arouses, sustains and regulates human and animal behaviour'.

There are no clear methods by which student motivation can reliably be achieved since people differ very much in what it is that 'turns them on'. Some teachers manage to motivate most of their students simply by their personality and manner and enthusiasm, but they can equally well fail to motivate the others. Similarly, the challenge of certain subjects is enough to motivate some students but to demotivate others. Or again, some students are motivated primarily by the desire to do well in exams and other forms of assessment, or by the desire to gain approval of their work by their teachers, whilst others are motivated by the future opportunities that learning seems to offer, and so on.

Experience, however, indicates that the natural proces of problem - solving motivates most learners, and develops many valuable transferable skills. But it does not necessarily lead to any other kinds of learning in the congnitive domain.

Attitude can be defined[8] as 'the way a person views something or behaves towards it, often in an evaluative way.' It includes many personal qualities such a diligence, obstinacy, willingness to co-operate, friendliness, etc.

Again it is not clear how to stimulate desirable attitudes or inhibit less desirable ones, although the example of others, especially of parents, teachers and peers, usually has a significant influence.

Value can be defined[8] as 'worth, merit, or importance'. Values include moral values, social values as well as aesthetic values.

To those motivated to learn, values can be taught simply by instruction; but the success of such teaching depends far more on the attitudes of the learners than does learning in the cognitive domain. The example of others is, of course, again important.

The above elements of the proposed Taxonomy of Learning are summarized in Fig. No. 2. The main difference between cogitive concepts and affective concepts is that the affective ones seem to lie even 'deeper' in the mind than the cognitive ones, and are consequently much more difficult to influence. It is difficult enough to familiarise students with such concepts as relativity or entropy, though it is well understood how it can be done, but it is not clear how, even in principle, attitudes and values (e.g. of hardened criminals) can be changed.

TYPES OF LEARNERS :

Research has shown that, where the

development of knowledge and understanding is involved, students differ as to their preferred learning styles.

- Some are 'doers' and like to be active in their learning; some are 'visualizers' and find visual images helpful in making information memorable and in supporting the internalization of new concepts; others are verbalizers and prefer to read or discuss or listen.
- Some students are 'holist' learners and like to begin with an overview of a subject, whereas others are 'serialist' learners and prefer a step by step development[9]. Books, which are naturally serialist in character, need

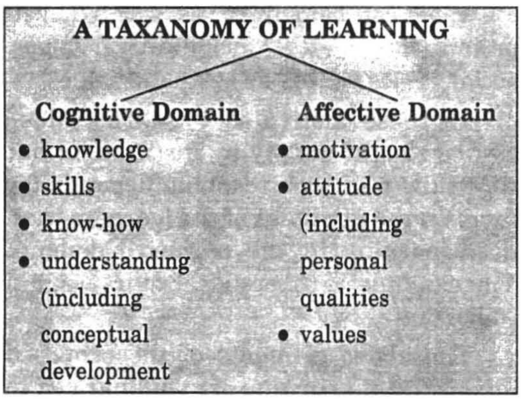

Fig. No. 2 : The Elements of the Proposed Taxonomy of Learning

therefore to include summaries, signposts, redundancy (as regards explanations of key concepts), explanatory figure captions, etc. so that holist students can easily read them in their preferred manner. On the other hand projects are holist in character so serialists may well need help with their approach to them.

Essential for the developments of understanding, and desirable for all kinds of learning, is the need to ensure that students adopt the 'deep approach' to learning (i.e. the intention to understand and challenge new statements) rather than the 'surface approach', which is the intention simply to memorize the information given and practice specified skills without question[10]. Overloaded courses often force students to adopt the surface approach even when acquiring understanding is the goal; and such students often do well since most typical exams, including those designed to test understanding, can usually be dealt with successfully with the aid of a good memory ! Better assessment methods are needed if understanding is to be tested properly. On the other hand, lightly loaded courses in which students fail to adopt a deep approach, and which are examined in conventional ways, are too easy for young people with good memories. So the tendency is to overload courses rather than improve the quality.

So if developing understanding is the aim, special efforts must be made (a) stimulate the deep approach, (b) to teach appropriately and (c) to assess appropriately. Problem - based learning can be good for stimulating the deep approach, but it is not sufficient on its own to teach understanding.

Note, however, that overtly 'active learning' has become the latest panacea for effective education, but like all generalizations it claims too much (!). It is absurd to suggest that 'Passive' activities, such as reading and attending lectures, cannot contribute to the development of understanding; but it is important to appreciate that they will only do so if the learners have 'active minds' and are already adopting a deep approach. So problem - based learning has a role to play, but it is by no means the complete answer.

DESIGNING COURSES :

The first step in designing courses, therefore, is to determine, in consulation with 'stakeholders' (as they are now called), the kinds of courses needed. Since it is not always easy for people to grasp the carefully defined concepts of knowledge, skills, understanding and know-how (rather than the common sense and much vaguer interpretations of these terms), s useful half-way stage is to describe well known kinds of courses in terms of these concepts. For example :

- *training courses* are mostly concerned with developing specialized skills or know-how, but with little further conceptual development.
- *general interest* courses, are mostly concerned with *knowledge* based on everyday levels of understanding, as well as with values.
- *up-dating* courses are mostly concerned with recent advances in specialized *knowledge* - the relevant specialised understanding being assumed.
- *awareness* courses are concerned with *knowledge* and *understanding* at a fairly superficial level (but no skill)
- First degree courses are concerned with *knowledge, skills, understanding, know-how* and *values* in varying proportions depending on the subject. Science degrees, for example, are mainly concerned with developing *knowledge* and *understanding.* Arts degree are mostly concerned with *knowledge, literary skills* and *value judgements.* Medicine is strongly dependent on *know-how,* since the working of the human body are still largely myterious. Engineering requires two kinds of degrees : one which emphasizes *understanding* and *integrative skills* for those who have to innovate successfully beyond current practice; and one which emphasizes *know-how* for those who can be expected to innovate within current practice. Both kinds of degrees are, courses, also concerned with *values* as well as *transferable skills* such as communication and interpersonal skill.
- *Upgrading* courses develop more advance *knowledge, skills* and / or *understanding,* usually for the purpose of gaining a further qualification.
- *capability* courses are similar to upgrading courses but concentrate more on know-how and are usually vocationally oriented.

So, as a first step towards achieving quality, as defined earlier, (especially in engineering) it is helpful to decide on the kind of course that is needed. It is then possible to sort out the kins of learning needed, and hence the mix of teaching methods to use in order to optimize the chances of achieving the intended learning goals.

TEACHING METHODS :

The range of teaching methods available in higher education tends to be limited in practice to the traditional ones of lecturing, tutoring, peer tutoring, laboratory activities, computer based learning of one kind or another, 'corrected' assignments, problem based learning (and 'apprenticeships') and projects. But each of these methods can be adapted to maximize one or other kind of learning, or a mixture of them. For example, tutorials[11] can be run as :

- *remendial tutorials,* in which students' problems are dealt with by the tutor, and their errors corrected. This is good for developing knowledge and skills.
- *teaching tutorials,* in which the focus is on the tutor, who explains and describes what is to be learned but ensures continuous participation by the students - much as in a good lesson in school. They can be adapted to any kind of learning except know-how, depending on the degree to which the tutor dominates the activity.
- *group working* in which the tutor is only a facilitator and stimulates students to explain things to each other and to sort out their own misunderstanidngs. For example, it is more important for the development of understanding for the students to explain to each other what they think they understand than to listen again to the tutor explaining what they think they don't understand ! Remedial tutorials can become Group working if students are required to explain to each other in pairs how they dealt with the set problems. To stimulate discussion and argument it is usually necessary to present students (e.g. at the beginning of the tutorial) with an immediate common experience which challenges their understanding.

Similarly, practical activities, whether in a laboratory or not, can be designed to :

- confirm statements made in a lecture
- discover facts
- develop measurement skills
- exercise experimental design skills
- improve understanding
- develop know-how
- improve communication skills
- improve interpersonal skills, and so on.

These difference in aim can be reflected in the designs of the activities.

In much the same way, all other methods of teaching can, to some extent, be adapted to optimize the development of different kinds of learning or combinations of them, though some are more limited than others. But to analyse each in turn is beyond the scope of this paper.

CONCLUSION :

The oft-expressed idea that quality in education cannot be defined but that you can recognize it when you see it, is essentially a conservative strategy, ill adapted to dealing with change. It is the basis of 'peer-review' which is widely used at present to assess quality. The key ideas behind a more objective way to achieve quality in higher education are shown in Fig. 3.

- Quality in higher education means 'specifying worthwhile learning goals and enabling students to achieve them.'
  - There are many factors to be taken into account in determining what is 'worthwhile'
  - Enabling students to achieve their learning goals' involves distinguishing between different kinds of learning and between different kinds of learners.
- To achieve quality, 'Everyone doing their best is not the answer, they must first know what to do.'

- Knowing what to do involves teachers and students knowing how to match their teaching and learning to the stated goals.
- Only then are quality assurance procedures needed to ensure that everyone continues to do their best.

Fig. 3 : The Basic Strategy for Achieving Quality in higher Education

The proposed Taxonomy of Learning breaks down the complex process of learning into distinguishable elements to which different teaching methods can be matched.

Thus the specification of a course or programme of study must not only refer to the *subject matter and topics* to be covered and the intended *level and standards* aimed at, but also to the *kinds of learning* involved. It is against such a specification, plus the success rate of the students, that the quality of the teaching and assessment in the education provided should be evaluated. The evaluation of quality assurance procedures is also an important matter, but a quite distinct one.

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Professor Sparkes may be contracted at 40 Sheethanger Lane, Hemel Hempstead, Herts HP3 OBQ, UK. He is an IEE member.

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