Is engineering education a professional activity?

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Abstract

In many countries schoolteachers are recognized by the public as "professionals" and school teaching is a professional activity for which some kind of specialist training is required. In some countries (e.g. Ireland and Scotland) standards of entry and subsequent behavior are regulated by councils similar to those that act in this respect for the health professions. In contrast, most countries do not require specialist training in education to become a university teacher which begs the question "is university teaching a professional activity?" With the recognition that faculty often play many roles, including those with aspects of research and service, here the focus is on teaching.

One characteristic of a profession is that it can set standards for entry into the profession and for the behavior of professionals in practice. How such standardization is achieved varies from country to country as does the status of the professional qualification. In both the United States and the United Kingdom a doctorate is the usual qualification for teaching engineering at the university level, not the Professional Engineer (USA) or the Chartered Engineer (UK) qualification. Thus many candidates for university teaching are newly qualified PhD's without any experience of engineering in the outside world. The PhD serves as a "standard" that qualifies a person to undertake research. Since a PhD is not a guarantee that a faculty member can teach or has been trained to teach, in one aspect of their careers many engineering educators will be "restricted" professionals [1]. Some countries however, such as the UK and Sweden, do require intending university faculty to have training in teaching and learning. It can be argued that such training serves as the teaching equivalent of the PE; the PEE, as it were.

All of this implies a second characteristic of a profession, that is, that it possesses a codified body of knowledge and expertise. A third characteristic of a profession is that it has agreed standards of behavior, and a set of ethical standards that members abide by or face sanctions for violating.

This paper argues that, certifications or degrees aside, university teaching should be a professional activity and effective training should be required. If engineering education is in fact a discipline—as declared in the United States the *Journal of Engineering Education* in 2006—then engineering educators have a responsibility for developing such training given that a substantive body of knowledge about teaching and learning in engineering exists. This paper discusses what might be expected of engineering educators should we choose to implement some form of teaching qualification and what steps might precede the development of such qualifications.

Introduction

Our intention is to propose an answer to the question "is engineering education a professional activity?" As we will demonstrate this is easier said than done.

Alternatively we could have asked, as has been done elsewhere for teachers [2], "are engineering educators professional?" or "are they members of a profession?" But, whereas there is no ambiguity about "teaching" and "teachers" there is an inherent ambiguity in the use of the term "professor" when coupled with engineering in a higher education context due to the multiple roles assumed by most engineering faculty. In an academic's role as a researcher they are likely pursuing some activities of a professional engineer; the overlap being dependent on what one's definition of what engineering and research are. When instructing students academics may be regarded as participating in the profession of teaching as defined by the study or discipline of teacher education (instructional theory and practice).

Alternatively it can be argued that the ability to teach (or mentor) could be regarded as an obligation of the profession (that is, to help apprentices develop). In this case there are professional obligations towards his/her students, and to fulfill these obligations academics would have to acquire and act upon the body of knowledge about instructional and curriculum practice. Either

approach leads to the premise that certain obligations are imposed on those wish to engage in engineering education and/or the training and professional development of engineers.

The growth of professions

In spite of the difficulties that sociologists have had in defining "profession" and "professional" and the view that "there is no such thing as a profession" [3] members of the public continue to use the word "profession" and the meaning ascribed to the term "profession" continues to expand. This is not surprising since claiming to be a profession builds prestige for the field that makes the claim. For example, numerous specialized organizations seek to become professional in both the UK and US. The growth in the number of new professions–which have been called second-level, sub or semi-professions [2]—arises from a search for prestige, status, esteem and power [1]. Specialization is the dominant source of occupational prestige. Hoyle makes the point that while esteem overlaps with prestige and status it is sufficiently differentiated concept, and analysis indicates that "esteem" relates to an individual's experience of a profession, which relates as much to university teaching as it does to school teaching. The extent to which a profession has political power is a function of its prestige and engineering institutions world-wide try to contribute to public policy.

Both teachers and engineers, however, are the victims of the rather trivial definitions of teaching and engineering held by the public and policy makers and both have sought the status of being considered a profession, as have myriad other specialized occupations. The term profession is utilized loosely in practice. For example there are over 200 different professional associations registered in just one US state New York [4]. The trend in the UK is similar. For example, the UK Passport Office instead of seeking a witness for the applicant of a passport from the traditional professions now includes the statement "…or professionally qualified person e.g. lawyer, engineer, doctor, school teacher, police officer or person of similar standing" [5].

Engineering, although long considered a profession, has not remained static in this changing space. Ever since the engineering institutions were established in the UK they have sought prestige and status. In the 1950's and 1960's engineers in the UK argued for an equivalent organization to the Royal Society and they were rewarded by the establishment of a Royal Academy of Engineering. Several years before that, American engineers had won a National Academy of Engineering distinct from the National Academy of Science signed into law by President Lincoln. Engineering has sought to protect its status as a profession, often by limiting entry. In the UK the engineering institutions with government approval limited the entry of member to those who had graduated from full-time educational programs. Thus in the 1960's and 1970's technicians were effectively barred from entry into the profession sought to found their own professional organizations in civil, electrical (electronics), and mechanical engineering [1] at the same time the government founded two

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[1] Up until then chartered engineer status could be acquired by part-time study for ordinary and Higher National Certificates (HNC) over a minimum period of six years. The HNC which could be achieved in five years was considered to be a technician qualification, although at the time, not spoken of as such. To acquire membership of the appropriate institution further studies called endorsements were required. During that period the Chartered Engineer (C.Eng) qualification was introduced: a person used the membership letters (e.g. MIE plus CEng after their name. The term/title "engineer" was not protected at the time. This remains the case and anyone may call themselves an "engineer". The title "C.Eng" is protected.

councils to validate the qualifications offered by technical colleges for business and technical technicians [6]. Eventually the Institute of Incorporated Engineers (IIE) was founded which brought electrical, electronic and mechanical engineering technician institutions under one umbrella [9][2]. Subsequently the IIE merged with the Institution of Electrical Engineers to form the Institution of Engineering and Technology (IET). It embraced technicians and technologists under the same umbrella in several ways similar to the way American IEEE embraces graduates with four year engineering degrees and those with degrees in technology. Similar politics have played out in teaching. In the UK the Office of National Statistics categorized the occupational status of teaching as a profession. In the United States large states such as California and Ohio have published standards for the profession of teaching [7]. While teachers are rightly concerned with the extent to which politicians, commentators and other professionals rank them as a profession, the public usually associates teaching as a non-professional activity, and this relates as much to university teaching as it does to school teaching. These examples illustrate how the concept of a profession changes. Clearly the extent to which a profession has power within the "political scene" is a function of its prestige.

The use of the term "professional"

To make the claim that teaching engineering or engineering technology within a university should be a professional activity this section explores how this loosely defined term might be used more precisely in engineering education. The etymology of "profession" arises from the Latin for public declaration and was first used in the Middle Ages as the vows one professed when entering a religious order. The meaning transformed over time first to mean the occupation one professes to be skilled in, then to mean those who are skilled in an occupation. The word "professor" comes from the same root, to mean an individual who makes a profession of expertise in art or science. Clearly to claim to be in a profession, or to be a professor, implies at least the obligation to have expertise in the area in question.

We shall use the term "profession" as it continues to be used semantically by the public which is to ascribe it to the particular knowledge and techniques that a person has and the behaviors brought by that person to the professional task. For example, in the UK the public accepts "Professional Footballers Association" and expects it to deal with those footballers who do not in public's eyes act as "good" role model as defined by the public's view of moral behavior. It is the same with the National Football League in the United States as the recent public furor over the league's tax sanctions of Ray Rice demonstrates. At the same time the public expects the members of the association to have a high level of technique and an obligation to use that technique to the best of their ability[3].

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[2] A documented commentary on the role of the Junior Institution of Engineers in this development has been deposited in the archive of the Institution of Engineering and technology by J. Heywood (2015).

[3] Currently teachers in secondary schools in Ireland are preparing to strike as a way of making known their reaction to proposals from the Department of Education and Skills for changes in the junior cycle curriculum and more especially the means of assessment. In an article in *The Sunday Times* (Irish edition 30:11: 2014) Conor Brady argues that the teachers' strike is the wrong answer to the junior cert question and in his article he calls teachers "frontline professionals", and again "teachers would demonstrate their commitment to their profession". He assumes, apparently, that being a member of a profession is consistent with being a member of a trade union. This seems to be the view of the doctors organizations in Ireland and the UK.

More than competence and behavior defines a profession, however. Davis, in a discussion of the engineering profession concluded that "ethical standards, not standards of competence or organizations, seem to distinguish professions from other skilled occupations" [8, p 29]. Ethics, Davis argues, creates ongoing tensions because there is no "systematic way to protect members of their profession who act ethically when an employer or client wants something else" [8, p 30]. In this context to be a professional is to abide by an ethical code as well as having a knowledge and technique base appropriate to that profession.

From the three criteria of expertise, behavior and ethical standards it is difficult to make the claim that engineering educators are professional. Many engineering educators do not subscribe to the body of knowledge on teaching and learning in a way that affects their practice, and it was only recently that ASEE published a code of conduct. It is the claim of this paper that for engineering education to consider itself as a profession a widely accepted code of conduct focused on education is paramount and nowhere is it more important than in the credentialing of students.

An example of the lack of professional characteristics on (engineering) educators can be found in one of the key features of the British higher education system, the use of external examiners.

> "*The purposes of the external examiner system are to ensure, first and most important, that degrees awarded in similar subjects are comparable in standard in different universities in the United kingdom, though their content does of course vary and, secondly, that the assessment system is fair and is fairly operated in the classification of students*"[9].

Warren Piper, however, pointed out that university staff are not professionally trained in the arts of teaching and examining and he noted "*that most professions have a monitoring the conduct of their members; might it be*", he asked "*that external examining could be regarded as a way that the academic profession keeps an eye on its own standards of conduct in the one area in which is their unique prerogative; the awarding of degrees?*"[10, p 2]. After investigating this proposition through a study of external examiners n his concluding sections he writes: "*As is abundantly clear from accounts given of examining practice in the written answers and interviews, respondents were almost always people of notable sophistication and great experience, many of whom thought deeply about their subject and its examination. For all that, there is little evidence, indeed, of more than a handful drawing upon a relevant body of theory and systematically collected evidence about examining in higher education. In the sense that their actions are not informed by a coherent body of knowledge, one has to say that external examining is not, on the whole, being conducted in a truly professional manner*" [10, p 235].

The same may be inferred from Heywood's study of assessment in higher education [11]. Given that the persons being credentialed (students) are being credentialed for a profession the minimal requirement should be that students be credentialed in a professional manner which suggests that those who do the credentialing should be trained [10].

Should engineering educators seek to be professional?

Given the presumed difficulties in meeting the criteria of expertise, behavior, and ethical standards evidenced by a code of conduct it is worth asking whether engineering educators *should* seek professional status in the larger sense of the word. The difficulties inherent in answering this question have already been alluded to earlier in the paper and relate to the way engineering educators are socialized into the university and how "engineering" is defined within academia.

Schools of engineering seek the best graduates from their or other schools for doctoral programs. Typically the most successful graduates are recruited directly into the university in a position that has defined duties in both teaching and research. Since they have no 'world' experience of engineering they bring a view of the profession of engineering that is based on their own life experiences, namely the application science to engineering problems. Just as in the case of British examinations their approach to teaching is intuitive, implemented with good intentions, but which conforms to their particular model of instruction and learning. Traditionally many faculty have not seen the necessity of having an educational knowledge base or be able to reason pedagogically either about teaching or the epistemology of knowledge of their subject [12] beyond what is required to meet the requirements for tenure. Such dispositions are part of the organizational culture of the university in which they work [13]. It should be noted, however, that the rise in the number of teaching and learning centers in the US during the last twenty years may mean this view is slowly changing [14]. In the UK a substantial organization supports the work of university teacher training and certificates are awarded for such study [4].

This lack of interest in aligning faculty teaching to a knowledge base of techniques is at the heart of the problems faced by educational reforms movements and the complaint that well documented research that has a power to influence students is not acted upon. Felder and Hadgraft express the issue in this way

> *"We believe that if engineering education research were stopped completely right now (which we are no way advocating), and engineering faculties could be induced to put into practice everything we currently know about teaching and learning from past research, cognitive science, and experience, then we would achieve innovation with impact to an extent beyond the wildest dreams of the most idealistic reformers"* [15].

If one believes that many of the axioms of learning and critical thinking were proposed by Saupé as long ago as 1961 [16], then the issue posed by Felder and Hadgraft can be simply rephrased as: *"The question then becomes, how can we get actions in the classroom to align with best practices?"*

One answer is to persuade engineering educators that to be professional is to have acquired a theoretical knowledge base, experimented with it, and drawn actionable inferences that guide their

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future practice. It matters not that they reject some of the findings, but it matters greatly for their integrity as educators that they are familiar with the knowledge base defined by the profession and have tested them. Otherwise their professionalism is "restricted" as defined by the attributes listed in exhibit 1.

Restricted professionality	Extended professionality
Skills derived from experience	Skills derived from mediation between experience and theory
Perspective limited to immediate time and place	Perspective embracing broader social context of education
Class (lecture) room events perceived in isolation.	Classroom events perceived in relation to institution policies and goals
Introspective with regard to methods	Methods compared with those of colleagues and with reports of practice.
Value placed on autonomy.	Value placed on professional collaboration.
Limited involvement in non-teaching professional activities	High involvement in non-teaching professional activities.
Infrequent reading of professional literature.	Regular reading of professional literature.
Involvement in CPD limited and confined to practical courses.	Involvement in CPD work considerable including courses of a theoretical nature.
Teaching seen as an intuitive activity.	Teaching seen as a rational activity.

Exhibit 1. Extended versus restricted professionality after Eric Hoyle [25] (cited by Heywood, J., in *Managing and Leading Schools as Learning Organizations: Adaptability and Change.* **Dublin. Original Writing for National Association of Principals and Deputies, p. 297).**

Many college students are seeking to find a job in an organization they regard as "professional", and they hope their education will enable them to succeed in such an organization. The desire to work in a professional organization and to develop the skill set to be recognized as a professional likely applies as much to every occupation, including teaching. Teachers want to be considered professionals, yet have taken little notice of Robert Runté's view that it is a waste of time worrying about the external validation of being a professional. Teachers are, he says *"knowledge workers... and as such we have a responsibility to both ourselves and our public to become reflective practitioners. As reflective practitioners we can reassert, first our ability, and then our right, to assume responsibility for the educational enterprise"* which in today's practice is to be professional[5]. Some might respond that that is what professional teachers do, or should do. It follows that persons' who enter higher education as educators have the same obligations.

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[5] Runté begins by noting the principle that suggests that people who go on strike cannot be professional. Yet teachers have gone on strike and doctors have threatened to strike. He points out that this issue only makes sense if these groups are in some different from other occupational groups. He takes the view that has been promoted by some sociologists that there is no such thing as a profession any more, and in support of this view he rehearses the two approaches that have been adopted for the analysis of professionalism – the trait approach and that of structural functionalism. He explains that whereas the structural functionalist had placed emphasis on the monopoly that the professions had over bodies of knowledge those monopolies had been broken. He was writing before the founding of Google and its impact on the collection and availability of knowledge. Some structural functionalists began to talk about the inevitability of deprofessionalization which was to promote the idea that teachers could never acquire professional status. " …they seemed to be saying that professional status was no longer relevant, since even doctors and lawyers no longer merited special consideration". Some sociologists introduced the term "knowledge worker". "So while teachers have been busily arguing over whether they should be considered professionals, sociologists have written the professions off …" he argues that teachers are not professionals because there is no such thing as a profession. This view applied to engineering leads to the rather frightening hypothesis that in spite of the ever increasing knowledge demands that are being made on the curriculum changes in the structure of the workforce are de-skilling engineers. Alternatively it could

Twenty years ago K. Patricia Cross, a distinguished specialist in higher education studies, gave the Educational research and Methods Division Distinguished lecture at ASEE's annual conference. She concluded that…

> *"…if we are to raise teaching to a more sophisticated level of development, classroom teachers are going to have to take more responsibility for generating knowledge about what and how well students are learning whatever it is teachers are trying to teach. Clearly that varies from discipline to discipline. True, there are some generic characteristics of good teaching, and most of us are far from the fullest possible development of those. But by and large, outstanding teachers will be developed through knowledge, sensitive observation of students in the process of learning, and perhaps most important of all, commitment to and respect for the profession of teaching"* [17].

Although this commitment is currently enacted by some fraction of engineering educators, it is generally perceived that such commitment provides little or no formal recognition. Thus the claim is that when engineers or engineering faculty decide to teach well they actually have to take on a second profession. If they wish to be as much a professional in their teaching as they are considered in their research, i.e. an extended professional, engineering educators will require both a code of ethics and a body of knowledge and resources for training that will enable them to act as researchers of their own classrooms[18]. Hidden in Warren Piper's text on examinations is perhaps the most powerful reason why engineers who wish to become educators should be professionalized is

> *"…higher education is an activity dedicated to the preparation of people to enter what our grandparents might have called the 'professional classes'. Thus, if the professional status of a teacher in higher education is derived from the occupation of teacher, rather than from the occupation for which his students are being prepared, the profession of teaching becomes unique: it is the only profession, if profession it be, which is dedicated to producing members of other professions"* [14, p 5].

If on the other hand engineering educators wish to be regarded as being a member of an expert occupation (Warren Piper) or knowledge-workers (Runté) why cannot that activity also be carried on in institutes other than a university? We may see this beginning to occur as technology opens up new pathways for education which bypass traditional universities.

Warren Piper draws attention to the idea that professionals, irrespective of their employer, have a first duty to their client. *"Essential to the relationship between professional and client is the gap in competence between them, the gap is usually large and the competence is based on the aforementioned specialist knowledge (the mysteries of the profession)"* [10, p 3]. This gap is not a new element of society, reflecting elements of the ancient Greek conception of *techne*, one of Aristotle's virtues, [19] which is the root of the word "technology". The ability to teach techne to any class of citizen, the necessity of *techne* to civilization, and the fact that experts can knowingly

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be argued of engineering educators that since they have no recognized knowledge base they are already de-skilled. We will leave that argument for the moment.

create mischief that only other experts can detect led to a distrust of *techne* and the view that if it posed a potential threat to both the state and existing social order. For example, only another physician can discover wrongdoing by a physician because of the "mysteries of the profession". Furthermore *techne* was associated with change and resilience: possessions can be taken from an individual but the skill *techne* represents cannot [20].

While it is easy to draw links between the curriculum of medical schools and the activity of being a physician, it is less easy to do this with engineering schools, as many former engineering functions are becoming automated to the extent they can be performed by individuals without an engineering degree. In both medical and engineering cases two 'knowledges' are required, both are skills in practice. The first skills are based in disciplinary expertise. In the case of the doctor it is skill in surgery or diagnosis; in serving as a physician knowledge is directed to practice. In so far as engineering education is concerned the balance between analysis, design and developing skills for practice is contended territory. Second are the skills required to teach. In order to teach medicine or engineering another set of skills and body of knowledge are required beyond the skills of the profession being taught. It is not clear if this body of knowledge of teaching is well codified within engineering education although one of us has attempted this task [21].

Conclusions and further thoughts

To conclude, this paper has laid out several criteria for being able to claim that engineering education is a profession: expertise that is codified in a form widely available to practitioners, agreed upon standards of behavior, and a set ethical standards that members of the profession abide by or face sanctions for violating. The body of knowledge of engineering education has been a focus of attention in the last decades, and has in fact stimulated doctoral degree programs at Virginia Tech, Purdue, and Utah State University. Other schools like Clemson have similar programs that build on longer established programs in the sciences.

Concerning the codified body of knowledge, a corollary to this claim this is necessary to professionalism is that if there is a separate body of knowledge for teaching and a person who is practicing teaching does not possess that body of knowledge then they are unskilled, and therefore at most a restricted professional. It is clear that a university or college would not hire an engineering faculty member who did not have some requisite knowledge of engineering. Can the case similarly be made that firms should not hire engineers who do not have some basic knowledge of education? Unlike law or medicine the bachelor's degree is effectively a terminal degree in engineering since in the US gaining licensure requires a degree from an accredited school and (typically) a minimum of four years of work experience under the supervision of licensed engineer [22]. The historical origin of engineering from military/ industrial practice means that a school is not the end of an engineer's education, but rather a grounding that is supplemented through practice on the job. Such training most often occurs under the tutelage of another engineer and depends on that engineer's ability to teach effectively. In fact some large, multinational engineering firms have brought expert engineering educators in to "teach the teachers" more effective andragogy which have resulted in significant cost reductions since the higher pas-rate in training courses means less time spent in training [private communication].

Similarly a field that does not have standards of behavior or an ethical code unique to that field cannot justifiably lay claim to be considered a profession. The authors suggest that if engineering education seeks to become a profession, or just more professional, a place to start is to attempt to develop a code of ethics that goes beyond that announced by the ASEE board of directors. The short term value is not the code itself but in the attempt to create a code that engineering educators could agree upon. There are many ways to frame the purpose of such a code. One of the more compelling arguments has been made by Kallenberg [23], who views the elements of a code as a series of "centers of conversation" similar to elements of engineering design. What are the elements of ethical behavior that then are worthy of discussion? Should elements of a code transcend both national boundaries and the diversity of engineering schools so the code can be widely adopted? Developing a code of ethics requires a vision of whom or what engineering educators serve; is it students, their institution, another profession, corporate interests, or society generally? Various educators codes of ethics emphasize conduct towards students, practices, colleagues, the profession, parents and the public [24]. Most importantly is there a unique code of ethics for engineering educators, or do existing codes of the engineering disciplines or of educators more generally adequately cover what should be expected of engineering educators? If a case cannot be made be made for a separate code of ethics the case cannot be made for a separate profession. At a fundamental, almost philosophical level, answering the question whether engineering education is, or should be, a profession involves asking who we really are and whether we can develop a unique identity.

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