Opportunities and Challenges in Professional Education-related Faculty Development in the US

Tristan T. Utschig, Dirk Schaefer
Georgia Institute of Technology, tris.utschig@cetl.gatech.edu, dirk.schaefer@me.gatech.edu

Abstract – **The authors outline important opportunities and challenges relating to formal education-related faculty development on a large scale. Questions explored are: What major opportunities exist regarding moving towards educational professional qualification for US Higher Education institutions, their faculty and students, industry, and society as a whole? How can resources be synergistically integrated to support such an effort? What are the major challenges or barriers present that must be overcome in order to create such a system? In response to these questions, a concept map is presented to explore how faculty educational development could support and greatly enhance an entire system revolving around faculty development in teaching and learning. Utilizing and reflecting upon the literature, major issues considered that relate to the questions above include various roles in the higher education engineering community; relationships between educational research, student learning outcomes, and engineering faculty; resources supporting engineering education, and the implication of different faculty reward structures. Analysis indicates that pieces already in place offer great potential to create the *Engineering Education of 2020* for "The Engineer of 2020" if key barriers are addressed.**

Index Terms – Faculty development, certification, teaching and learning, engineering education.

INTRODUCTION

In this paper the authors define a number of categories to consider as the US moves towards providing The Engineer of 2020 [1] with a matching *Engineering Education of 2020* fostered by education-related faculty development. A recent article by ASEE President James Melsa states as much when he urges that "we must take action now on what we know about improving engineering education"[2]. He also alludes to the fact that their will be numerous roadblocks on the journey forward despite the great advances made in recent years. In this paper, the opportunities and challenges Melsa alludes to are discussed utilizing a concept map of faculty development as its primary organizing focus (see Figure 1).

I. A Vision

Imagine it is three weeks into the semester. You are a new faculty member teaching a course involving group projects for the first time and would like to help your student teams operate more effectively. You know there is a college of engineering workshop on managing student teams next month that you will attend. There, you will learn about managing teams and will work with colleagues in a team under conditions similar to those you would like your students to experience. During the workshop your team will even produce a rubric you will later use for a major assignment in your course – but you don't know that yet. Nonetheless, you don't want to wait to begin improving the learning environment you are creating for your students. Before the workshop, you freely speak to your teaching and learning mentor and colleagues across several disciplines looking for suggestions. They point to current best practices in the literature, assessment instruments that can help your students understand the criteria for effective team performance in an engineering environment, suggest ways to help you reliably measure student performance, and even offer to visit your class and act as a peer coach to give you real-time feedback. What's more, your students are able to give you thoughtful and valuable feedback about their team needs due to experience in previous courses where they have developed significant professional skills working in both formal and informal groups and were provided the opportunity to reflect on those learning experiences.

II. A Reality

Now imagine that only three years earlier none of this was possible. Enrollment had been declining, student motivation was low, resources regarding teaching and learning on campus were nearly non-existent, and faculty rarely communicated across disciplines or even within disciplines. Unfortunately, this latter description would appear closer to the truth than the former in many cases, though examples of success in transitioning between these scenarios do exist [3, 4]. So, what are the opportunities and challenges schools will face as they move towards the vision above?

Support for the vision above will need to come from a variety of sectors within US engineering education. The US cannot reach a goal state demonstrating this type of visionary outcome on a broad scale without a significant national effort. Opportunities and challenges pertaining to this effort in the US context are described below.

III. Issues Impacting Faculty Development

Four major categories impacting the engineering education community regarding teaching and learning are outlined here. The categories arose from analysis of the concept map shown in Figure 1. The concept map outlines numerous

factors impacting faculty development within the engineering education community. However, the factors can be broadly classified using the four categories in Table 1.

TABLE I
IMPACTS ON THE ENGINEERING EDUCATION COMMUNITY

Category	Color	Description
Roles	Green (medium shading)	Institutional, departmental, and individual goals and needs each impact faculty development activities regarding teaching and learning in different ways.
Rewards	Light Blue (light shading)	Grants, prizes and honors, publications, participation in research, tenure, promotion, and other activities or recognitions are all important in promoting faculty development for teaching and learning.
Resources	White (no shading)	Funding and organization of faculty development activity comes from governmental, private, industrial, and institutional sources.
Relation-ships	Gray (dark shading)	Students, faculty, administration, and other partners are all stakeholders in communities of practice revolving around teaching and learning.

Below, each category is analyzed within the context of US engineering education to highlight opportunities and challenges they present in implementing any large-scale program for faculty development in teaching and learning. Conclusions are drawn from a synthesis of the discussion.

BACKGROUND

I. International Context

A review of faculty development programs in engineering education around the world is presented by the authors in [5]. In that paper, an overview of models of professional qualification, development and recognition for those teaching in Higher Education selected from across the world was presented. It has become apparent that many countries have realized the benefits and value that professionally qualified educators may add to their institutions, education of their future leaders in engineering and science, and hence society in general. Furthermore, there is evidence showing the positive impact on student learning from such programs.

In the US, the introduction of professional development programs for higher education faculty as well as professional certification and registration are still a highly controversial socio-political topic. However, a set of three critical elements for success in such faculty development program have been previously presented by the authors [6]. On successful completion of an accredited education-related program, participants can get registered or certified as professional practitioners of engineering education. The three critical elements are: (1) support by a nationally respected society or academy, (2) utilization of qualifying criteria or standards at several levels [(a) Theory – foundations of teaching and learning, (b) Scholarship – educational research and scholarly work in the field, (c): Practice and Portfolio – reflective teaching portfolio development and peer mentoring], and (3) flexibility in implementation across a variety of university administrative structures and cultures.

Considering the guidelines above, the question becomes "How do we proceed from here"? It is clear that there

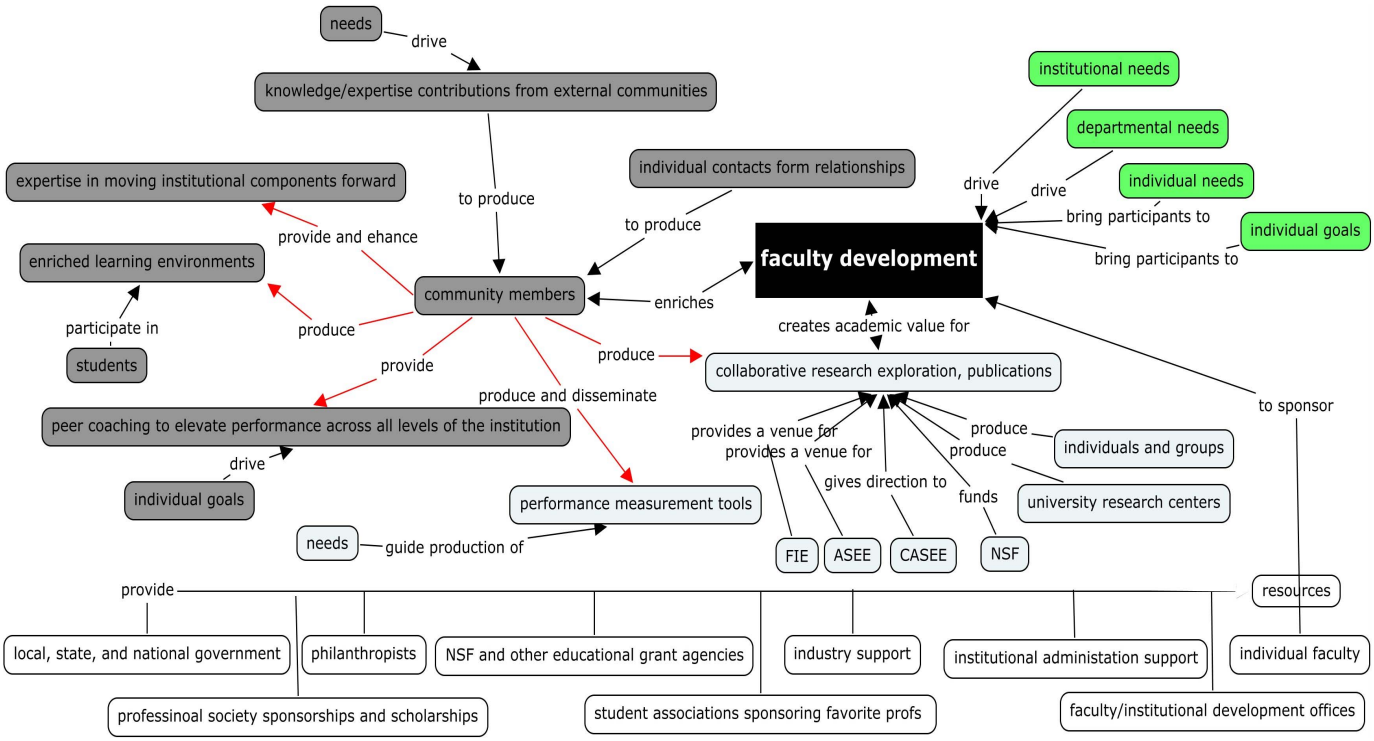

FIGURE 1
CONCEPT MAP OF FACULTY DEVELOPMENT IN ENGINEERING EDUCATION.

is a major opportunity for the US to innovate and provide new leadership in faculty development for teaching and learning within engineering based on what we can learn from the international community. Thus, we now summarize the literature relating to each of the four major categories defined in Table 1.

II. Roles for Teaching and Learning in the US

How does the literature inform the way higher educational roles impact faculty development in teaching and learning?

A recent FIE panel discussion investigated this issue and found that multiple levels of recognition and responsibility may be helpful [7]. These may parallel the hierarchy of faculty roles already present in most institutions. Integrating newly defined roles in teaching and learning and developing people to successfully fill those roles will require a shift in thinking. Elements of this shift are described by Barr and Tagg [8] who discuss moving from a teaching to a learning paradigm in higher education, and by additional resources describing institutional change [9-12]. Furthermore, such a change will encourage faculty to continuously evolve and develop their skills. The development of cultures of assessment encompassing both personal development and development regarding student learning will be needed to support these shifts [13].

Another aspect of faculty roles in higher education is that many faculty will serve in multiple roles simultaneously. Despite evidence of shifts towards separate teaching faculty and research faculty the norm is still to expect both. With careful faculty development planning, these roles for individual faculty members can be balanced for success. Critical aspects for faculty development to foster success in these roles (particularly regarding teaching and learning) are reported in a study by Boice [14].

Finally, the teaching role has traditionally been very autonomous. Shifting towards public sharing in a community of practice mode will require this role to change shape. It has been suggested that a code of ethics be employed through which faculty development efforts can be implemented while ensuring that faculty autonomy can be respected [15]. Another autonomous role which is now increasingly publicly shared involves the assessment and evaluation of student learning. This assessment role is now shared through departmental and institutional channels that increasingly serve as significant factors regarding teaching and learning. This has occurred via the implementation of the outcomes based accreditation process and national calls for greater accountability in higher education. Felder and Brent discuss how faculty roles impact attainment of ABET accreditation and, specifically, address teaching and learning techniques relating to ABET accreditation criteria. [16]

III. Rewards for Teaching and Learning in the US

How does the literature inform us about what types of rewards impact faculty development in teaching and learning?

First and foremost among rewards for faculty are achieving promotion and tenure (P&T). P&T criteria include teaching and learning components in different ways and with different relative importance at different types of institutions. However, it is certainly addressed in all cases. Arreola describes a method for quantifying the various aspects of P&T [17] to reflect departmental and institutional priorities. Significantly, many examples show that these priorities have been evolving, through changes in language regarding requirements for promotion and tenure that reflect greater emphasis on attaining excellence in teaching and learning. This is occurring at institutional and even state levels, giving an official and primary line of recognition for excellence in teaching [18] and even may require scholarly work in teaching and learning [19]. Unfortunately, some of this language has been slow to be embraced and is often ignored by individual departments. Nevertheless, it has been used to successfully support a number of individual cases.

Further evidence of evolving expectations regarding teaching and learning in engineering are reflected in the following three areas. First, national leadership through the Center for the Advancement of Scholarship in Engineering Education prompted a serious discussion about how to re-engineer the academic reward structure [20]. Second, two recent books about the scholarship of teaching and learning (SoTL) reflect on the recent growth of this activity and cite quality examples from engineering [21, 22]. These authors have also served to further define what SoTL means and explain ways that faculty can participate in SoTL. Third, peer reviewed venues for disseminating work in engineering education are growing. A recent example: ASEE has just moved to a "publish to present" format with required peer review across the entire conference [23].

Finally, the reward of prestige for faculty in engineering often comes in the form of CAREER grants from NSF. These grants now have required educational components. Additionally, NSF grants such as the Course, Curriculum and Laboratory Improvement (CCLI) grants and others add important pieces to faculty promotion and tenure portfolios. These grants require elements addressing the broader impacts of the work and clear dissemination plans. These elements are often faculty focused (within and across institutions) and include significant faculty development activities relating to teaching and learning. Lastly, educationally related prizes and fellowships are often connected with faculty development activities and SoTL projects. One example was the Carnegie scholars program. Case studies of the SoTL work of Carnegie Scholars and how it impacted those individual faculty are presented by Huber [24].

IV. Resources for Teaching and Learning in the US

How does the literature reflect funding and human capital available to achieve faculty goals regarding development for teaching and learning in engineering education?

The importance of funding for faculty development in engineering education must be recognized. NSF grants and

awards (with broader impact and dissemination plans mentioned above) are perhaps the most obvious examples of where these funds come from. However, much of this funding is research related with teaching and learning being smaller parts of the overall project. Thus, the educational components of these grants may be viewed as "forcing functions" driving faculty development activities.

A second source of funding which supports faculty development in teaching and learning for engineering education is funds from private and corporate philanthropic foundations. Examples include the Ford [25], Lilly [26], and Hewlett [27] foundations. These projects tend to support educational activities directly and thus faculty pursuing this kind of support are often seeking faculty development in teaching and learning on a purely voluntarily basis.

In terms of human capital, two major points need to be made. Increases in community college funding and attendance over past decades have resulted in placing much greater numbers of students at institutions where teaching and learning are the primary faculty role [28]. As such, the faculty serving these students represent a sizable demand side to faculty development in teaching and learning. Also, the teaching and learning centers at colleges and universities which provide faculty development programming have seen huge growth in their numbers [29]. Thus, the supply side of human capital for faculty development in teaching and learning is also increasing. However, it is interesting to note that teaching and learning centers are more prevalent at research universities than at community colleges. This fundamental mismatch will need to be addressed as faculty development in engineering education moves forward.

V. Relationships for Teaching and Learning in the US

How does the literature describe the complex relationships among different stakeholders in engineering education as important ingredients in achieving superior performance for educational outcomes?

Faculty-student, administrative-faculty, and other constituent relationships must all have their values and interests represented if the types of changes needed to meet the vision described in the introduction above are to come to fruition. A methodology to effectively plan for community impact (here meaning the engineering education community) is described in a book from the Harvard Business School Press called Cultivating Communities of Practice [30]. Another way to view the many aspects of constituent relationships is described in the well-known Boyer Commission Report. This report suggests that the teaching and learning environment at universities be viewed as an ecosystem with various interacting relationships [31].

These holistic approaches can be complimented by a deep understanding of individual relationships among the various stakeholders in engineering education. Faculty-student relationships may be the first paring that comes to mind for many. Major studies using a multitude of approaches have demonstrated the value of this student-faculty relationship. It has been shown that faculty "distance" is an important negative factor in student learning and, most particularly, whether students are ultimately successful in pursuing an education in engineering [32, 33]. Decreasing this distance can occur through the use of a number of student active pedagogies such as problem-based learning, cooperative learning, and others. These pedagogies have been demonstrated to be extremely effective in producing high student achievement for many learning outcomes. The value of partnerships with students as participants rather than receptacles is well documented in the literature [34-36].

VI. Utilizing Existing Knowledge

The work above outlines that fact that the literature offers significant knowledge about each of the four categories impacting faculty development as defined in this paper. However, the purpose of this paper is to present opportunities and challenges present in the US regarding faculty development in teaching and learning for engineering education rather than to present any potential solutions. Again, it should be noted the authors have developed as set of guidelines revolving around three Critical Aspects of Faculty Development in Teaching and Learning which is presented elsewhere [6]. The three critical elements are presented again here to provide additional perspective on the discussion below:

1. Programs should evolve and be supported by a *nationally respected society or academy*.
2. Programs should be supported by *qualifying criteria or standards at several levels* of expertise with clear criteria at each level and should include both practicum and training components.
3. Programs should accommodate *flexibility in implementation.*

WHAT ARE THE OPPORTUNITIES AND CHALLENGES CURRENTLY EXISTING IN THE US FOR FACULTY DEVELOPMENT IN TEACHING AND LEARNING?

Table II below presents numerous opportunities and also significant challenges regarding moving forward with widespread and extensive faculty development for US higher education in engineering. The elements of the table are divided into the four categories described in Table 1. They correspond to individual elements or groups of elements from the concept map presented in Figure 1 and are informed by the literature review presented above.

CONCLUSIONS

Fortunately, current conditions in the US, as outlined in Table II, display more opportunities than challenges. This indicates great potential for moving forward. Fostering and growing relationships among the various constituents in the engineering education community, along with delivering rewards that match the language in mission statements and professional expectations for promotion and tenure, are certainly possible under current conditions. However, the challenges (though relatively smaller in number) still

TABLE II
OPPORTUNITIES AND CHALLENGES REGARDING IMPLEMENTATION OF FORMAL EDUCATION-RELATED FACULTY DEVELOPMENT ON A LARGE SCALE

	Opportunities	Challenges
Roles	• *To provide clarity of purpose for all in educating our students (society).* • *To make the various roles of professional educators transparent to key stakeholders of the university system (students, parents, industrial partners).* • *Have a multi-level structure of professional educators who teach in engineering disciplines (higher education, vocational training, short courses for continuous professional development, etc.).* • *For high-level associations (NAE, ASEE, ABET, NSF, etc.) to help define minimum content of professional development programs and accredit such programs.* • *Capitalize on admin heavy participation in leadership of national organizations like NAE, ASEE… to effect change.* • *Departments – chairs have opportunity to guide outcomes.* • *For institutions/department to certify individuals completing professional training programs.*	• *As of today, there is no formal qualification needed to teach in Higher Education.* • *PhD in core technical area does not necessarily mean professor is qualified to be an effective educator.* • *There is no professional recognition for educators.* • *Institutions – retain independence in light of pressures from national organization such as NAE, ASEE, NSF, etc.* • *Leading change for all in the face of traditional faculty autonomy …* • *Additional requirements and classifications based on demonstrated teaching knowledge/skills/ability.* • *Disconnects between different needs for different roles.*
Rewards	• *Formal recognition and certification for individual educators (faculty) after successful completion of a program (equivalent to P.E. in Engineering Education).* • *"Excellence in Learning and Teaching" recognition and certification for institutions/departments with a certain minimum percentage of professionally trained educators.* • *Alignment of formal faculty recognition with institutional missions.* • *Preferred consideration/eligibility regarding grant applications (funds for learning and teaching related research and development projects) for certified institutions/departments.* • *Better education for students taught by formally qualified and certified educators.* • *Faculty freedom to embark on different or additional research area: scholarly Engineering Education related research.* • *Additional flexibility in presenting P&T portfolio contents* • *Increase of revenue for certified institutions/departments by offering professional educational programs at various levels of certification to other departments and/or external participants.* • *Influence/power: certified institutions/departments/individuals may be asked to serve on high-level committees or task-forces charged with shaping the future of engineering education.* • *Long-term, the number or percentage of professionally trained educators may play a role in accreditation.*	• *National interest in and awareness of professional Engineering Education needs to be raised significantly.* • *Change of perception: traditional engineering faculty needs to be persuaded that Engineering Education as a research area is valuable and important in any branch of engineering.* • *High-level associations, such as National Academy of Engineering, ABET, ASEE, ASME, IEEE, etc. need to buy into professional development programs and convey to engineering institutions and departments that they are expected to move toward that direction.* • *Raise competition for and value of rewards giving recognition for excellence in teaching and learning.* • *Setting up a national committee to oversee formal recognition and certification process.* • *Get industry support/buy in.*
Resources	• *Interdisciplinary research synergy leading to additional grant opportunities.* • *Current engineering education community can take on the responsibility to leader in this field of professional development.* • *Established teaching and learning centers with engineering expertise may use their resources (faculty, staff, and facilities) to offer programs to other departments and external academic units or participants.*	• *Administration of professional development programs across all levels (national, state-wide, institutional, departmental).* • *Significant seed funding is needed to develop, administer and establish programs, publish materials, advertise etc.* • *Increasing funds (internal and external) for teaching facilities and equipment.* • *Providing time for faculty to take part in such programs.* • *Enhancing data demonstrating impact of faculty development in this area: ex; Flagship pilot programs targeting various levels of certification are needed to demonstrate usefulness and impact.*
Relation-ships	• *Cross-disciplinary research between faculty from engineering and education leading to joint scholarly publications and research grants.* • *Funding agencies can further emphasize relevance of educational components to their programs.* • *Closer collaboration between high-level associations to jointly shape the future of Engineering Education at a national level.* • *Elevate public image and occupational status of engineering educators.* • *Raise students' and parents' confidence in education offered at higher education institutions.* • *High-level associations can work together toward a common goal.* • *More frequent and active participation in international Engineering Education community to compare US standards to European and Asian standards in order to become leaders on a global scale.*	• *Institutions and departments do not have sufficient personal able to foster such developments.* • *Overcome fear of making teaching and learning a public exercise rather than autonomous activity.* • *Convey to public all the roles of an educator. They need to understand that it means much more than the traditional teaching at school as practiced decades ago.* • *Agree on how to evaluate performance on common scales and utilizing all stakeholders.*

represent significant barriers. Resources, both in funding and human capital, will always be insufficient unless a clear shift in roles occurs such that professional development and faculty performance in engineering education philosophically become clear competitors with research. Currently, there is no infrastructure in place to support a philosophical shift in how faculty, departmental, and institutional roles can leverage widespread implementation of faculty development as educators in engineering. Nonetheless, overcoming these barriers is essential. Without doing so it will be virtually impossible to offer an *Engineering Education of 2020* that achieves the learning outcomes desired for The Engineer of 2020.

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AUTHOR INFORMATION

Tris Utschig, Assistant Director, Center for the Enhancement of Teaching and Learning & Adjunct Assistant Professor of Nuclear Engineering, Georgia Institute of Technology – Atlanta Campus, tris.utschig@cetl.gatech.edu

Dirk Schaefer, Assistant Professor of Mechanical Engineering, Georgia Institute of Technology – Savannah Campus, dirk.schaefer@me.gatech.edu