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A Proposed Teaching and Learning Curriculum for COMPLEETE Based on Current National Trends

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Abstract—We propose an introductory level teaching and learning curriculum for the ASEE COMPLEETE program (*COMPetencies in Learning for Engineering and Engineering Technology Educators*). COMPLEETE is an initiative for a national program to build and recognize educator excellence in engineering and engineering technology at three levels. The proposed curriculum for the introductory level is compared with curricula from nine well-established existing programs. The content is specifically targeted to benefit engineering and engineering technology instructors in higher education, integrate with the values and programs already offered within ASEE, serve as a foundation for further development at higher levels, and be flexible to suit the needs of a diverse instructional community. The nine existing programs were coded under the overarching COMPLEETE criteria and then analyzed for commonalities and alignment. The proposed core competency areas were found to comprehensively represent existing programs. They are: learning theory, student development, instructional design, instructional facilitation methods, assessing and providing feedback to learners, instructional technology, and reflective practice. The proposed curriculum lays a foundation for those offering faculty development services to compare against, and challenges the engineering and engineering technology community of educators to address key competency areas all faculty should develop within 3-5 years of beginning teaching.

I. INTRODUCTION

We propose an introductory level teaching and learning curriculum for COMPLEETE. The ASEE COMPLEETE Program (*COMPetencies in Learning for Engineering and Engineering Technology Educators*) was described in an award winning "Best Paper" at the 2010 ASEE conference under the name SPEED (Strengthening the Performance of Engienering and Engienering Technology Educators across the Disciplines) [1]. COMPLEETE is an initiative for a national program to build and recognize educator excellence in engineering and engineering technology. This recognition occurs as the educator progresses through three levels of achievement. The proposed curriculum in this paper targets a succinct set of core competencies representing the first level of achievement, yet remains flexible to serve the needs of faculty with diverse approaches to teaching and learning. This flexibility is achieved in part by inviting a wide array of faculty development providers to contribute to COMPLEETE programming. In other words, there may be many paths (through multiple providers) for participants to reach each level of achievement in the COMPLEETE program, but all paths must satisfy the same set of competencies.

The national debate about how to move faculty toward achieving new levels of competency in teaching and learning for the modern world (and for what purposes) is fueled by several important publications over the past decade or so. These include the revised ABET accreditation criteria published in 2000 and 2004 [2], the reports for *The Engineer of 2020* and *Educating the Engineer of 2020* from the National Academy of Engineers [3, 4], and ASEE's two recent reports on *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education* [5, 6]. The proposed curriculum responds to these calls by integrating curricula from many well-established, existing programs to form a single vision for a set of core teaching and learning competencies that all faculty can benefit from possessing, and which can move the engineering and engineering technology community of educators forward towards achieving the ideals proposed in these publications.

This work may be useful to faculty development practitioners to assist in planning curricula or individual workshop topics that are consistent with other programs and with generally agreed upon areas of competence. It may also be useful if they wish to contribute directly to COMPLEETE by offering programming that helps instructors build competence in the areas specified for the proposed curriculum. Finally, it may also be useful to educational researchers investigating instructional practices, and by instructors as a means to identify areas where they might strengthen their knowledge and skills.

Faculty development programs for which comparisons were made include STEMES [7], EXCEED [8], Pacific Crest [9], NETI [10], U-Michigan [11], Northern Illinois [12], and CIRTL's Delta program [13] within the US, plus international models from the UK [14] and IGIP [15].

These programs have informed the structure and content of the proposed curriculum, which is specifically targeted to benefit engineering and engineering technology instructors in higher education.

The COMPLEETE project proposes three levels of attainment for engineering and engineering technology educators. These are a foundational level representing critical areas of competence which contribute to building quality teaching and learning environments in any setting, a scholarly practitioner level where participants further strengthen their skills and begin to systematically investigate learning in their classrooms, and a reflective mentor level where participants contribute and give back to the engineering and engineering technology community of practice [1]. Here, we address only level one, defining the goals and outcomes associated with this level of attainment as consistent with the vision for the COMPLEETE program. We address only level 1 because the initial efforts of the COMPLEETE program will focus on this level, and further because the proposed curriculum will likely be adapted community input, implementation, and review, thus defining more detailed needs for levels 2 and 3 over time.

Level 1 – Foundations

A. *Proposed Level 1 Aims:*

- To provide an overview of teaching and learning practice and theory in Engineering and Engineering Technology Education, addressing the core knowledge and professional values educators are expected to have to be able to teach effectively and efficiently at their respective institutions.
- To begin to establish in participants a culture of reflective practice and evaluation of their own teaching practice, and of the learning of their students; and to build a broader community of practice among practitioners.

B. *Proposed Level 1 Learning Outcomes:*

Upon successful completion of Level 1 participants will:

- Have evaluated aspects of their current teaching practice within the context of learning and teaching literature (reflecting knowledge and critical understanding of the following teaching and learning activities: teaching and the support of learning; contribution to the design and planning of learning activities; assessment and giving feedback to learners; developing effective learning environments and learner support systems).
- Have gained an understanding of the learning process, drawing on recognized learning theories.
- Have developed an understanding of students, including issues of intellectual and social development, learning styles and differences in student approaches to learning.
- Have been engaged in instructional design at lecture, module, course or curriculum level.
- Have been exposed to various methods of instructional delivery, including an overview of teaching methods appropriate for different instructional goals and environments, including both large and small classes.
- Have designed and used appropriate methods to assess student learning and give feedback to learners.
- Have developed an understanding of how to make effective use of educational technology.
- Have engaged in reflective practice and continuous learning.

The proposed curriculum which accompanies these goals and intended outcomes is built from the overarching criteria proposed in the COMPLEETE project as presented in various publications over the past three years [1, 16-19]. The curriculum revolves around seven areas of core competency which were first articulated as a synthesis of faculty development needs by an experienced faculty development expert in engineering on the original SPEED team and then revised based on discussion among others on the SPEED and, later, COMPLEETE project team. The seven areas or core competence are shown in Table 1.

TABLE I. CORE COMPETENCY AREAS

Area	Title
1	learning theory
2	student development
3	instructional design
4	instructional facilitation methods
5	assessing and providing feedback
6	instructional technology
7	reflective practice

It is also consistent with previously proposed critical elements for successful faculty development programs at a national level in the US [20] and serves as one response to numerous call for national reform. Finally, it integrates with values and programming already present within ASEE [21], serves as a foundation for further development at higher levels, and is flexible to suit the needs of a diverse instructional community.

II. METHODS

The content of nine existing faculty development programs was coded for commonalities and alignment with the overarching COMPLEETE criteria using a qualitative methodology. This was first done individually by each of the authors. Then, two rounds of feedback among the group were utilized in order to come to greater consensus. The coding process used was based on a grounded theory approach [22-24]. The feedback process was designed to

follow, to the extent possible within a limited group of three experts, a modified Delphi procedure which has been used on other educational contexts to build consensus about complex concepts [25-28].

A. Producing initial individual rankings

The details of the process used to produce the individual ratings (before coming to consensus) in Table 1 are as follows:

1. Program materials for each "comparison curriculum" (in the form of publicly available basic program outlines that might be provided to potential participants in those programs) were assembled into a single document and distributed to each member of the rating team via email for printing.

2. Each content item listed in the program materials for each "comparison curriculum" was mapped to the "equivalent" content items in the COMPLEETE curriculum using the pre-determined codes represented in Table 1. Content items in the comparison curricula could be words, sentences, or phrases present in the materials themselves. The coding process was simplified via the use of a number system to represent the codes and thus reduce writing on the "comparison curriculum" materials:

   Each rater then wrote the appropriate number directly on the "comparison curriculum" materials. This process of assigning codes consisted, of course, of judgment calls, as text did not always match exactly. Rather, the general area or meaning of the wording in the comparison curricula needed to be interpreted by each rater. Further, it was possible to associated multiple COMPLEETE curriculum items with a single "comparison curriculum" if needed, and vice versa.

   If a "comparison curriculum" item did not match with any COMPLEETE curriculum item, this information was recorded separately so a mechanism to track the items the COMPLEETE curriculum did NOT cover was established.

3. Assignments for a level of agreement for the "comparison curriculum" with the COMPLEETE curriculum were made. This was accomplished by ranking the relative frequency of the presence of each numbered content item and applying the matching scale defined below:

   > X = Not present in "comparison curriculum"
   > 1 = Present by inference, or as subtopic of a major area

   > 2 = present as a major aspect of the "comparison curriculum"

4. Results were recorded in a blank table with the same form as Table II.

B. Building Consensus:

Once the individual ratings were complete, a comparison table displaying the ratings from each of the three raters was produced and distributed. Two rounds of feedback were then conducted to produce a greater level of consensus.

First, a phone conference was scheduled to discuss ratings where both X and 2 appeared from different raters for the same "item" in a particular comparison curriculum (the term item here is used to represent a cell in table 1, where each cell is a comparison between one core competency in the COMPLEETE curriculum with a particular comparison curriculum). There were eight items in this category. During the phone conference each rater discussed their rationale for their individual rating, and then an opportunity to change ratings was provided. Results from the discussion (along with any modified ratings) were recorded on a new spreadsheet. No items with both X and 2 remained after discussion. In other words, at least two of three raters had come to full agreement for each item, with the other rater differing by one level.

Second, remaining items where two raters agreed but a third had assigned a different level of curricular agreement were discussed. Approximately half of the items fell into this category. Discussion for these items occurred over two separate phone conferences (due to lack of time to complete the process in a single conversation). To help resolve those items where there were differences, the raters agreed that the person with a different rating than the other two should look at the materials a second time and either (a) change their rating to match the others, or, (b) write a short justification trying to convince the others why their rating (as based on their coding of curricular content) was correct. This process was completed for one rater before the first phone conference and the others at a later date. Approximately two thirds of the discrepancies were resolved in this manner.

Finally, the combined ratings for level of agreement on each item were tabulated through a simple numerical average of the three raters final scores at the end of the discussion process. In should be noted that in order to produce a numerical average, the "X" level of agreement was assigned a value of "0" for this purpose.

III. RESULTS

Table II displays the results of our curriculum comparison. The core competency areas compared are those defined in Table I: learning theory, student development, instructional design, instructional facilitation methods,

assessing and providing feedback to learners, instructional technology, and reflective practice. Results show that reflective practice and instructional technology have the lowest level of concordance with the COMPLEETE curriculum. Instructional design, and instructional facilitation and methods have the highest concordance. Also, it should be noted that the programs used for comparison vary greatly in length. A few details for each program are shown at the bottom of Table II. About half the programs are multi-day affairs where participants are together for several consecutive and intense days. Other programs consist of courses one takes during semesters over a period of one or more years (CIRTL Delta and U-Michigan), or modules to be completed either individually or with a group through various means over a period of one or more years (Pacific Crest, UK, and IGIP). This latter group is more consistent with the COMPLEETE approach where participants may progress through the level 1 curriculum over several years and continue to grow throughout their career at levels 2 and 3.

TABLE II.   CURRICULUM COMPARISON

COMPLEETE Core Module	STEMES	EXCEED	Pacific Crest	NETI	U-Michigan	Northern Illinois	CIRTL Delta Program	UK HE Certificate	IGIP
learning theory	1	1	2	1.7	2	2	2	2	2
student development	1	1	2	0.7	1	1.3	2	2	1
instructional design	1	2	2	1	2	2	2	2	2
instructional facilitation methods	2	2	2	2	1	2	2	2	2
assessing and providing feedback	2	1.7	2	1	1	2	1	2	1
instructional technology	1	1	2	1	X	X	2	2	2
reflective practice	1	X	1	X	0.3	1	2	2	1
TOTAL	**9**	**8.7**	**13**	**7.3**	**7.3**	**10**	**13**	**14**	**11**
Program length	Three or more days, all at once	Six days, all at once	One year or more, spread out	Three days, all at once	Two or more semesters, consecutive or spread out	Three to five days, all at once	Two or more semesters, consecutive or spread out	Usually three consecutive semesters	Self-paced, usually one or more years

After discussion about the overall results, the team selected a limited set of compulsory core competencies for the introductory level along with several additional optional competencies among which participants might choose to form their complete introductory level curriculum. Below, each competency (or module) is broken down into distinct components that might be addressed in single instance workshops of a half-day or less such that one might be able to piece together a complete curriculum by using a variety of faculty development resources. We derived these components from previously published descriptions of the competency areas and then refined them based on our discussions about the content of the comparison curricula. Details for the components of each core competency (or module) follow:

DRAFT MODULE STRUCTURE for LEVEL 1

The first five modules are proposed as required modules for all COMPLEETE participants. These modules are well represented in existing curricula and thus form a broad and generally agreed upon foundation of teaching and learning competencies desired for engineering and engineering technology educators.

A.   Core Module 1 – Learning Theory:

Outcome: Understanding the learning process, drawing on recognized learning theories.

Narrative: A practical overview of theories of learning and teaching in Higher Education, with a focus on the disciplines of engineering and engineering technology. This includes an overview of current cognitive and constructivist learning theories with a focus on their application to undergraduate instruction.

- Understanding student learning
- Constructivism
- Approaches to learning: deep learning, surface learning, strategic learning
- The Kolb learning cycle
- SOLO taxonomy of levels of understanding
- Bloom's taxonomy of learning
- Learning styles
- Problem-based Learning
- Project-based Learning

B.   Core Module 2 – Student Development:

Outcome: Understanding students, including issues of intellectual and social development, learning styles and differences in student approaches to learning.

Narrative: An introduction to understanding elements of student development which impact teaching and learning

such as students intellectual and social development, learning style preferences and approaches to learning.

- Encouraging student motivation
- Teaching and learning in small groups
- Teaching and learning in large groups
- Student supervision: one on one, e.g. projects, theses, dissertations, etc.
- Reflective practice
- Ethics

C. Core Module 3 – Instructional Design:

<u>Outcome</u>: Introduction to instructional design, including both course and curriculum design.

<u>Narrative</u>: An introduction to the theory of constructive alignment (of intended learning outcomes, learning and teaching methods and assessment) to be used in course and curriculum design.

- Organizing teaching and learning
- Outcome-based planning
- Module and course design
- Constructive alignment (Biggs)

D. Core Module 4 – Instructional Facilitation Methods:

<u>Outcome</u>: Instructional delivery, including an overview of teaching methods appropriate for different instructional goals and environments, including both large and small classes.

<u>Narrative</u>: An overview of instructional techniques that might be employed in large group or small group teaching situations, with an emphasis on approaches that might shift the environment of the classroom from teacher-centered instruction toward student-centered learning.

- Structuring lectures
- Increasing student-teacher interaction
- Managing the Classroom Learning

E. Core Module 5 – Assessing and providing feedback to learners:

<u>Outcome</u>: Designing and using appropriate methods to assess student learning.

<u>Narrative</u>: Purpose of assessment, principles of assessment, formative and summative assessment, methods of assessment, assessing groups, peer and self-assessment, devising assessment criteria, providing feedback.

- Assessment and evaluation
- Formative and summative assessment
- Methods of giving feedback

- Assessment methods/tools
- Developing rubrics

The next two modules are proposed as electives. A COMPLEETE participant would choose at least one of these two modules to attain level 1 in the COMPLEETE curriculum. Some, but not all, existing curricula address these modules in a significant way.

A. Elective Module A – Instructional Technology:

<u>Outcome</u>: Making effective use of technology.

<u>Narrative</u>: An introduction to available tools and the effective use of technology to promote learning, including principles of e-learning.

- E-learning
- Virtual Learning Environments

B. Elective Module B – Reflecting on learning and teaching:

<u>Outcome</u>: Engaging in reflective practice and continuous learning

<u>Narrative</u>: An introduction to the role of reflection in professional practice.

- Reflective practice (currently this topic remains distinct to this module, but upon further discussion will likely be distributed throughout the curriculum, with a focus reach in this elective module)
- Developing portfolios
- Classroom peer observations

IV. CONCLUSIONS

This proposal has the following implications: first, it lays a foundation for organizations/groups to compare against. When considering the needs of engineering and engineering technology educators, we have now established a comprehensive curriculum which encompasses input from many existing programs, is consistent with the literature calling for education reform, and represents a national platform for recognizing scholarly attainment in teaching and learning for engineering and engineering technology educators. Second, it lays a foundation to design levels 2 and 3 of the COMPLEETE curriculum. This curriculum is not intended to be offered as a "one and done" type of curriculum. Rather, it mirrors the journey one takes throughout their career as an educator. Third, it challenges the engineering and engineering technology community of educators to own up to what competency areas all faculty should be developing regarding their instructional responsibilities. One can sometimes improve from experience as an educator, but dramatic improvements across the entire community require mutual understanding of core competencies by everyone. In that way the entire community can work together to strengthen their skills and

foster measurable improvements in student success. Finally, we hope it extends the national conversation in this area and incites some debate. We invite comments and critique from faculty developers, researchers in engineering and engineering technology education, and individual instructors. As the COMPLEETE program moves forward we expect that the debate about how best to strengthen and recognize achievement in our community of educators will take shape at national conferences and in publicly visible space on the web. We hope you will join the conversation.

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