Technology in Engineering Education: What Do the Faculty Know (and Want) Anyway?

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Abstract

We have conducted a survey of engineering faculty at the eight SUCCEED coalition universities to identify the training needs and present levels of experience with various technologies. The results of that survey are presented in this paper.

The most surprising finding from the survey is that, despite the wide differences in the Coalition's colleges of engineering (in size, student demographics, and research-teaching emphasis, for example), the survey results are similar for all campuses. This is important in that it implies that the survey results may be widely applicable to other universities, even given the disparate state of technology integration and availability across campuses today.

Generally, the survey found a high correlation between interest in attending a workshop with a low skill level with the workshop topic, as expected. Of the ten potential workshop topics, those in highest demand include:

- Developing multimedia courseware or modules.
- Developing Java applets to enhance courses.
- Creating Web pages for a course to provide information and distribute course materials.
- Creating, editing and incorporating multimedia into course materials.
- Developing a course delivered entirely via the World Wide Web.
- Holding electronic help-sessions or office hours.
- Presenting lectures or class demonstrations from a computer.

Introduction

Information technology holds great promise for enhancing the teaching and learning processes. Correctly designed and implemented, it promotes active learning, addresses the various learning styles of students, and is more accessible to students via the Internet or on portable media, either synchronously or asynchronously [1, 2, 3]. While examples of successful technology-based learning environments aimed at specific courses or topics abound, a large proportion of faculty

simply do not have the skills needed to undertake the development of such projects, or even to borrow and revise them for their own use.

The Southeastern University and College Coalition for Engineering Education (SUCCEED), an NSF-sponsored engineering education coalition composed of the engineering colleges of eight southeastern universities, is committed to a comprehensive revitalization of undergraduate engineering education for the 21st Century. The eight institutions comprising SUCCEED are: Clemson University, Florida A&M/Florida State University (FAMU/FSU), Georgia Institute of Technology (Ga Tech), North Carolina A&T State University (NCA&T), North Carolina State University (NCSU), University of Florida, University of North Carolina-Charlotte (UNCC), and Virginia Polytechnic Institute and State University (Va Tech).

The coalition has identified four themes, or Focus Areas, which it will target for improving the teaching and learning enterprises. These Areas are Faculty Development, Assessment and Evaluation, Student Transitions, and Technology-Based Curriculum Delivery. More information on these Focus Areas, as well as the coalition itself, can be found on the Web at http://www.succeed.vt.edu/ .

The goal of the Technology-Based Curriculum Delivery (TBCD) focus team, the working committee for this Focus Area, is to support the effective use of technology in enhancing the learning and teaching environment in the coalition's colleges of engineering. In preparation for achieving this goal, the TBCD focus team plans to offer a series of workshops targeted at introducing various technologies and building skills in faculty members to facilitate technology incorporation. In order to provide the appropriate training, at the appropriate level of expertise, the team must undertake an assessment to determine the needs of the faculty in the coalition schools. This effort includes a faculty survey. The results of the survey also serves as the baseline for later assessment of the effectiveness of the TBCD efforts.

Survey Design

The TBCD focus team decided on the following set of design criteria for the survey:

- It must be brief, so that faculty do not view it as a time burden.
- It must be readily accessible to complete, and simple to return.
- It must gather a wide range of information, including demographics, and skill and interest levels in various topics.

The first criterion was met by the final survey design, which was limited to two pages with 20 questions. To meet the second criterion, it was decided to distribute surveys to the TBCD representative on each campus for distribution and collection. E-mail and Web-based surveys were considered, but would most likely have biased the results, which was undesirable for a baseline study. Finally, the survey design was compact and efficient, we believe, and facilitated the gathering of a large amount of information.

Results

Of the 1622 surveys distributed at the eight campuses, 360 were returned for a response rate of 22.2%. Response rates from individual campuses ranged from a low of 9.5% to a high of 40.4%. All disciplines of engineering (including technology) were represented among the respondents, and the number of respondents in each discipline roughly reflects their predominance on campuses (e.g. electrical/computer, mechanical, civil engineering had the highest numbers, architectural, bio/biomedical, mining/minerals, nuclear engineering had the lowest).

Table 1 shows demographic information of the respondents. Note that not all 360 respondents completed all survey questions, which accounts for the Total values in Table 1 being less than 360. Generally, respondents from larger campuses (Clemson, Georgia Tech, NCSU, Florida, and Va Tech) are comprised of more Full Professors than Associate or Assistant Professors. The remaining, generally smaller, schools have a more uniform distribution between the three ranks. All schools show a low percentage of Adjunct, Instructor and Other faculty who responded. Survey distribution to these faculty groups was non-uniform across the campuses and, therefore, it is likely that they are under-surveyed.

	All schools		Clemson		FAMU/FSU		Ga Tech		NCA&T		NCSU		Florida		UNCC		Va Tech	
RANK	#[a]	%[b]	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Full Professor	141	40.4	24	42.1	7	33.3	13	39.4	8	25.8	16	41.0	29	44.6	7	29.2	37	46.8
Assoc. Professor	104	29.8	17	29.8	5	23.8	11	33.3	11	35.5	12	30.8	14	21.5	11	45.8	23	29.1
Assist. Professor	77	22.1	13	22.8	8	38.1	6	18.2	7	22.6	8	20.5	17	26.2	3	12.5	15	19.0
Adjunct Professor	5	1.4	0	0.0	1	4.8	0	0.0	3	9.7	0	0.0	1	1.5	0	0.0	0	0.0
Instructor/Lecturer	6	1.7	3	5.3	0	0.0	0	0.0	0	0.0	1	2.6	1	1.5	0	0.0	1	1.3
Other	16	4.6	0	0.0	0	0.0	3	9.1	2	6.5	2	5.1	3	4.6	3	12.5	3	3.8
Total	349		57		21		33		31		39		65		24		79	
YEARS AS FACULTY																		
More than 20 years	109	32.0	22	39.3	3	14.3	9	31.0	5	16.1	13	35.1	16	25.0	7	29.2	34	43.0
10-20 years	101	29.6	13	23.2	6	28.6	9	31.0	10	32.3	10	27.0	27	42.2	7	29.2	19	24.1
7-10 years	35	10.3	7	12.5	1	4.8	3	10.3	3	9.7	3	8.1	7	10.9	4	16.7	7	8.9
3-7 years	47	13.8	5	8.9	2	9.5	6	20.7	9	29.0	6	16.2	6	9.4	3	12.5	10	12.7
0-3 years	49	14.4	9	16.1	9	42.9	2	6.9	4	12.9	5	13.5	8	12.5	3	12.5	9	11.4
Total	341		56		21		29		31		37		64		24		79	

[a] Number of respondents

[b] Response as percentage of total

Table 1: Demographic information of survey respondents, both as a summary of all coalition schools, and as individual campuses.

Regarding the years of service as a faculty member, it is interesting to note that, for the coalition as a whole, faculty with more than ten years of teaching experience represent a high percentage of all faculty. In fact, with the exceptions of FAMU/FSU and NCA&T, this group of senior faculty represents the overwhelming majority. We have no current data on the length of service of faculty, either in all disciplines or in engineering, so it is not known whether this finding is particular to engineering faculty or to SUCCEED's engineering schools.

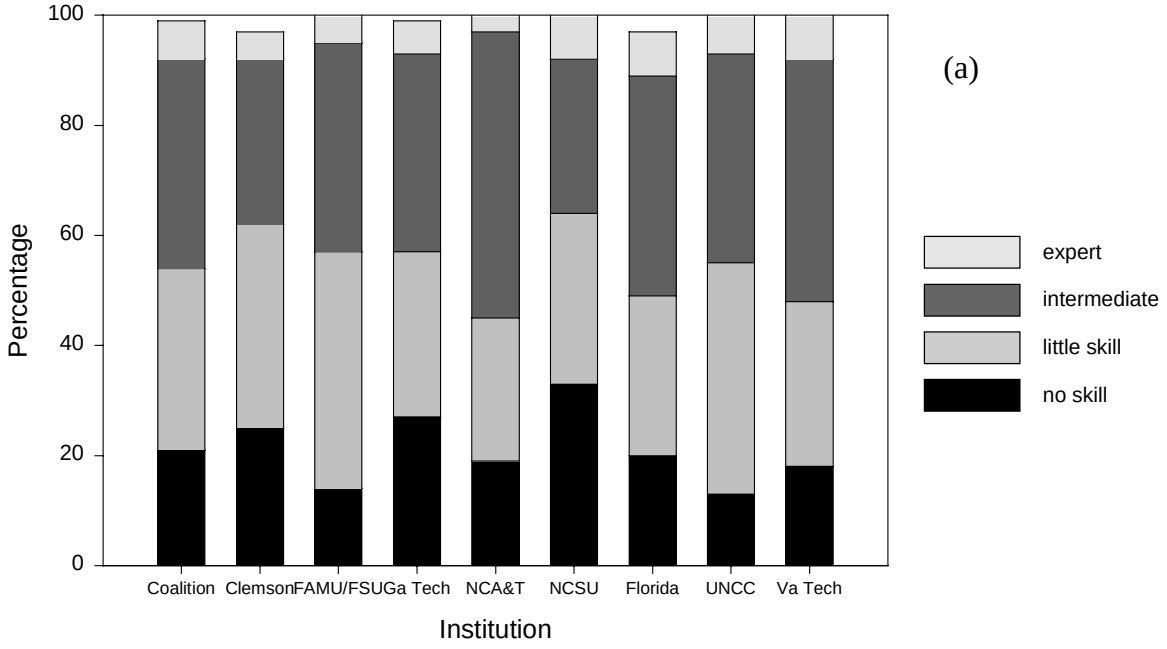
As for workshop duration preference, the respondents indicated their preferred length for a workshop or seminar to be overwhelmingly 1-2 hours (42.5%) or half-day (40.3%) long, as

opposed to an asynchronous (on-line) format (10.0%) or other format (7.2%). We assume the shorter duration would be of a seminar or overview format, perhaps solely for information gathering or demonstration, while the half-day duration would suggest a hands-on workshop format. The preference for a short workshop also implies that the respondents are not willing to travel very far to attend the workshop.

Interestingly, 28.1% of all respondents indicated that they know of other staff members or students who may wish to attend a workshop or seminar on one or more of the topics listed. The response rate of individual campuses to this question ranged from 18.8% to 38.6%, with no correlation with school size or research-teaching emphasis of each campus. In response to the follow-on question, however, respondents at large campuses indicated much higher numbers of staff or students who may be interested in attending a workshop. These results indicate that, at all campuses, significant numbers of non-faculty are thought to be interested in obtaining training in course-related technology, especially at the larger campuses.

Figure 1 (a) and (b) show typical responses to two questions from the survey with respect to the faculty's skill level. Each plot shows the percentage, either for all respondents or for respondents from each school, on self-rated skill level in each topic. The first question concerned the respondent's skill in creating, editing and incorporating images into course materials using the computer (Fig. 1a). The second concerned the respondent's skill in creating a Web page for a course to provide information and distribute course materials (Fig. 1b).

The most noticeable feature of these figures is the uniformity of distribution of skill levels across the coalition schools, despite the wide differences between the schools in terms of, for example, the school and faculty size, student demographics, research-teaching emphasis, and technology access and implementation.



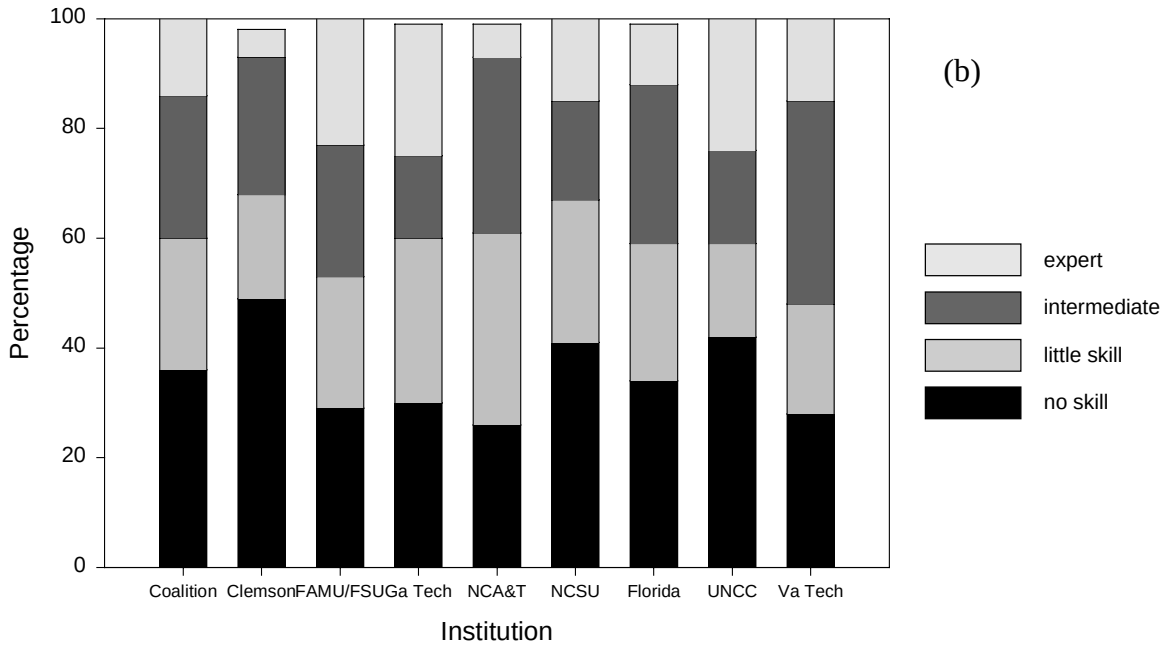


Figure 1: Survey response to potential workshop topics, both by individual schools and as a summary for all coalition schools.

To further assess the interest and need for various workshops, the survey asked two additional questions:

- Would you attend a workshop on this topic?
- Are you already using this technology for teaching?

The results to these questions are shown in Table 2, which shows the percentage of all respondents who (i) have 'little' and 'no skill' in the topic, (ii) would attend a workshop on the topic (answered 'yes' as opposed to 'no' or 'maybe'), and (iii) are already using this particular technology for teaching.

The correlation in Table 2 is clear: Topics for which a high percentage of faculty have little/no skill are those for which they would attend a workshop. Among the ten potential topics, those in highest demand are:

- Developing multimedia courseware or modules using commercial authoring tools (Topic #5).
- Developing Java applets to enhance courses.
- Creating Web pages for a course to provide information and distribute course materials.
- Creating, editing and incorporating multimedia (graphics, videos, photos, etc.) into course materials (Topic #4).

- Developing a course (lectures, tests, assignments, etc.) to be delivered entirely via the Web.
- Holding electronic help-sessions or office hours using conferencing or collaboration tools.
- Presenting lectures or class demonstrations from a computer.

Generally, the workshop topics in highest demand also correspond to topics that have the lowest percentages of respondents who said they are already using the technology, as expected. The sole exception to this is the creation of Web pages for a course (Topic #7), in which a relatively high percentage have little/no skill (60%), there is a high demand (39%), but yet a high percentage are already using this technology (34%). This suggests that faculty members value this technology, perhaps see potential uses for it in teaching, and want more advanced training.

Workshop Topic	*Percentage of all respondents who …*			*Demand-to-Need Quotient (DNQ)*
	have little and no skill	*would attend workshop*	*already use this technology*	
1. Using email	7.5%	8.5%	61.%	nc
2. Using word processing	4.4	6.4	70.	nc
3. Presenting from computer	38.	28.	41.	0.73
4. Using multimedia	54.	39.	25.	0.72
5. Developing multimedia	83.	41.	7.2	0.49
6. Using the WWW	25.	19.	41.	nc
7. Creating Web pages	60.	39.	34.	0.65
8. Electronic help-sessions	87.	35.	5.8	0.40
9. Developing a Web course	86.	38.	5.0	0.44
10. Developing Java applets	92.	40.	3.1	0.44

Table 2: Percentage of all survey respondents who (i) have little and no skill with the topic, (ii) would attend a workshop on the topic, and (iii) are already using the technology for teaching. The Demand-to-Need Quotient is defined in the text. DNQ not calculated (nc) for some topics because demand was low (arbitrarily chosen threshold of 25%) and skill level was high. Data shows summary information for all coalition schools.

Discussion

The demographic information for the respondents can be compared with data collected by Felder et al. [4], who also surveyed the engineering faculty in SUCCEED institutions for the purpose of assessing the effectiveness of faculty development efforts. While the response rate of their survey was higher (35% vs. 22%) the findings are very similar, suggesting that our two surveys have similar sampling of SUCCEED faculty, and that the results may be cross-correlated in the

future. The similarity between the distributions of faculty rank and the years of faculty experience of the two surveys is seen in Fig. 2.

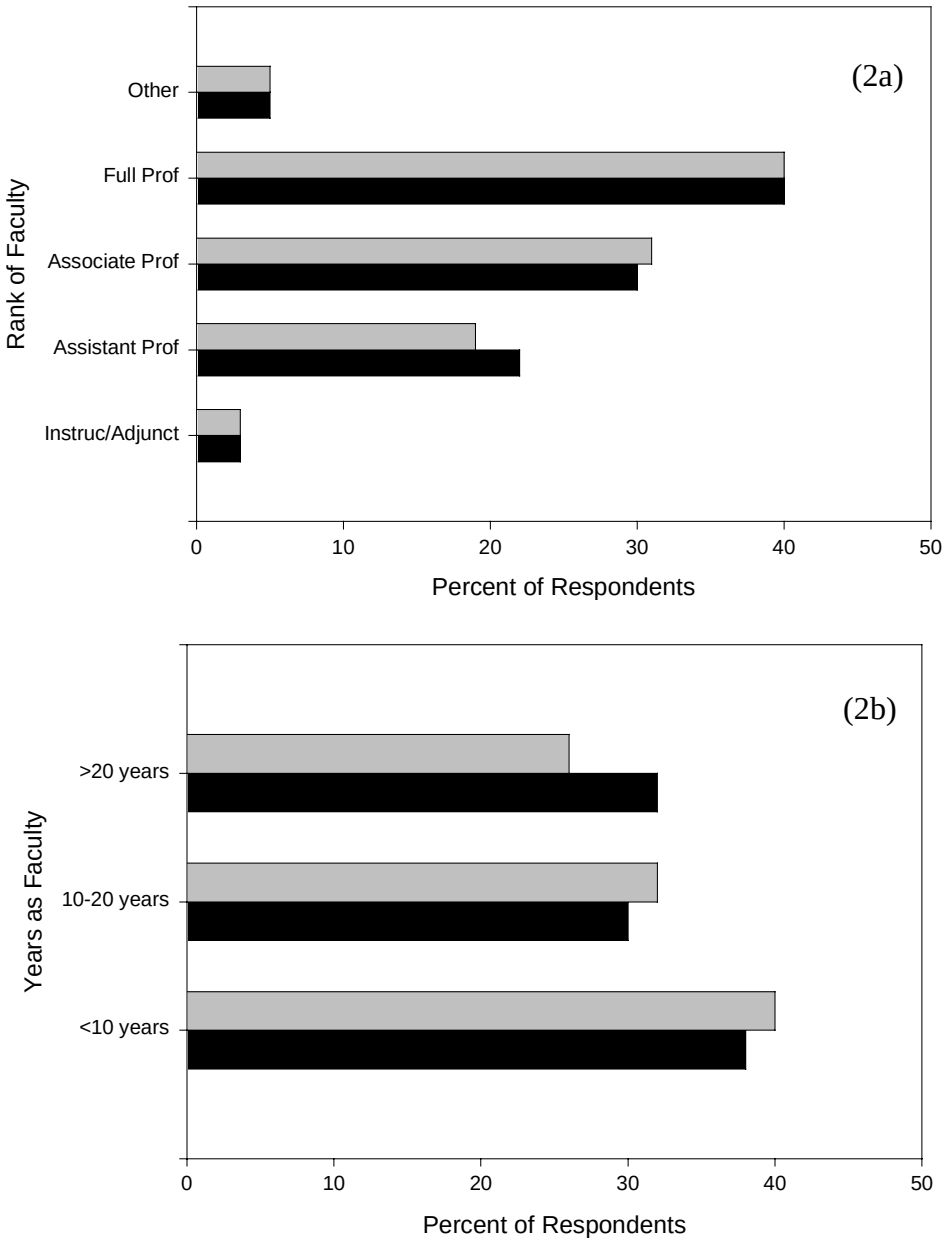


Figure 2: Comparison of demographic data between this survey and that of Felder et al. [4]. Fig. 2a: faculty rank, and Fig. 2b: years of service as faculty. Note that the categories for years of service have been changed to allow for cross-survey comparison.

The preference of respondents for workshops or seminars that last 1-2 hours or half day suggests that the preferred format would be a workshop delivered on-campus (thus eliminating travel time). For some potential workshop topics, this requirement may pose a significant hurdle in terms of the technology infrastructure that must be in-place and supported at the campus. For

example, a workshop about technology for holding electronic help-sessions or office hours using conferencing or collaboration tools will require both hardware and software, which is determined by the workshop conductor, to be available on site.

In determining the priority of workshops to be delivered, it is important not simply to prioritize according to the demand by faculty (see Table 2). What is perhaps more valuable is to examine the Demand-to-Need Quotient (DNQ), which we define to be the ratio of the percent of respondents who would attend a workshop on a particular topic to the percent of respondents who have little or no skill in that topic. The DNQ is tabulated as the last column in Table 2. A relatively higher DNQ implies that the respondents both want this workshop topic and already possess more than a low skill level with this technology. This is an important factor to consider since it is possible that some respondents with little or no skill in a particular topic may simply be interested in 'information gathering' about the topic, as opposed to having knowledge about it and wanting to adapt it for use in teaching. We believe the latter case should take precedence as workshop topics.

Viewed in this manner, the workshop priorities should be as follows, in decreasing order of importance as measured by the DNQ:

- Presenting lectures or class demonstrations from a computer.
- Creating, editing and incorporating multimedia (graphics, videos, photos, etc.) into course materials.
- Creating Web pages for a course to provide information and distribute course materials.
- Developing multimedia courseware or modules using commercial authoring tools.
- Developing a course (lectures, tests, assignments, etc.) to be delivered entirely via the Web.
- Developing Java applets to enhance courses.
- Holding electronic help-sessions or office hours using conferencing or collaboration tools.

Conclusions

A survey of all engineering faculty at eight SUCCEED coalition schools were conducted in order to assess the training needs and present levels of experience with various technologies. Despite wide differences between the engineering colleges surveyed, the results were similar for all campuses, and thus may be applicable to other universities.

The results showed a high correlation between interest in attending a workshop with a low skill level with the workshop topic, as expected. When account was made of both high demand *and* existing skill, the priority of workshops was changed.

Acknowledgement

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