AC 2011-231: DETERMINING IMPACT OF A COURSE ON TEACHING IN ENGINEERING

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For over fifteen years he has been involved in scholarship of teaching in learning. He annually offers a course entitled "College Teaching in Engineering" with an annual enrollment averaging 30 students. He has authored or co-authored sixteen papers in the past eight years related to teaching and outcomes assessment in engineering.
Determining Impact of a Course On Teaching in Engineering

Abstract

A course entitled “College Teaching in Engineering” has been offered to more than 300 individuals over a fourteen year period. Students have included graduate and undergraduate students and a small number of faculty from the across the College of Engineering. It could be expected that students experiencing a structured course on teaching in a discipline will be more likely to pursue a teaching career, approach teaching in a scholarly way, and be a successful teacher. However, there is little data available to support this hypothesis. This paper contributes to such data based on an analysis of a combination of course evaluations at the time of offering and a survey of former students (course alumni).

A qualitative analysis of written responses to a question regarding course impact on their teaching was done for both responses received through end of course evaluations and alumni surveys. The responses were place into six major categories based on Fink’s Taxonomy of Significant Learning. The respondents unanimously indicated the course had an impact. Although in both data sets the Fink Categories of fundamental knowledge and application received the highest percentage of responses; all categories did receive responses. In addition, there was a significant shift from fundamental knowledge to integration between the post-class and alumni response sets. The content and distribution of responses would indicate an understanding of a breadth of concepts involved in creating a significant learning experience was part of the impact of the course.

Alumni survey questions focused on specific class objectives. An interesting immediate impact was implied by a reported change in their own approach to learning as a student. Although comparative data is not available for non-course participants, other indicators of involvement, like their reading about and discussing teaching, participating in the scholarship of teaching and learning, were at significant rates.

The course does appear to have positive impact on both students who move on to academic careers and those who do not. Students’ perceptions and analysis of their responses indicate they are better prepared for the teaching element of an academic career.

I. Introduction

Improvement of engineering education is a multi-faceted challenge. There are strong reasons to focus on helping graduate students become more effective educators. A significant opportunity for contributing to improvement is to motivate well qualified engineering students to consider the profession of teaching and to enhance their preparation for this career path thereby addressing the faculty pipeline issue. Second, the national need to change the way students are educated has been well established. Examples of approaches to these two facets include the National Effective Teaching Institute (ASEE), activities of the New Engineering Educators Division (ASEE), the NSF Engineering Education Scholars Workshops, and individual courses and academic programs at engineering institutions.
It could be expected that students experiencing a structured course on teaching in a discipline will be more likely to pursue further preparation for a faculty role, follow a teaching career, approach teaching in a scholarly way, and be a successful teacher. This paper reports the results of an assessment of the impact of an academic course entitled “College Teaching in Engineering”. The course has been offered thirteen times over a fourteen year period, with a combination of undergraduates, graduate, post-doctoral students and a small number of current faculty and staff with more than 300 completing.

II. Future Faculty Preparation Programs

In a review of the development and characteristics of future faculty preparation programs, it is pointed out that they can provide a smooth transition between graduate school and faculty positions. These programs evolved from TA training programs that proliferated between 1960 and 1990. Establishment of the Preparing Future Faculty (PFF) program in 1993 formed a base for a sustained national initiative to transform doctoral education. The PFF program has three core features of 1) addressing the full scope of faculty roles and responsibilities, 2) students have multiple mentors and receive reflective feedback and 3) both are addressed in the context of a cluster of institutions typically involving a doctoral degree-granting institution with various partners.

Although no generic template exits, many programs offer some combination of: courses, seminars, and workshops; development of materials such as portfolios and/or web pages; collaboration with partner institutions; experiential activities; mentoring opportunities; and coverage of contemporary issues in higher education. In general they promote a more holistic approach to graduate education. The Ohio State University is typical of a number of institutions currently offer, specializations, minor or certificate programs which both structure and document the accomplishment of the student. Required courses often include teaching effectiveness and process. They most often covers the topics of theory and practice in teaching and learning at the college level, including how to establish student learning goals, develop a syllabus, use diverse approaches to teaching, and assess student learning.

Preparation for the profession of engineering itself presents unique and changing challenges. The National Academy of Engineering points that “Although certain basics of engineering will not change, the explosion of knowledge, the global economy, and the way engineers will work reflect an ongoing evolution.” A recent study of engineering education, found that “in the midst of profound, worldwide transformation in the engineering profession, undergraduate education in the United States is holding on to an approach to problem solving and knowledge acquisition that is consistent with practice that the profession has left behind. There are, however, pockets of innovation, and these, along with the example of medical education and new findings from the learning sciences, suggest to us that engineering educators can transform their programs so that students’ learning experience more effectively prepares them to meet the new demands of professional practice.” Changing expectations and refined definition of outcomes for engineering education are reflected in accreditation criteria. ABET criteria for engineering are intended to assure quality and to foster the systematic pursuit of
improvement in the quality of engineering education that satisfies the needs of constituencies in a
dynamic and competitive environment.\(^8\)

Options do exist for current faculty to gain pedagogy knowledge and skills. For example,
Felder and Brent\(^9,10\) reported the results of a longitudinal survey of faculty participating in the
National Effective Teaching Institute (NETI). NETI is a three-day teaching workshop for
engineering faculty given annually in conjunction with the Annual American Society for
Engineering Education Conference. Surveys were sent to 607 alumni of the institute since it
started in 1991. The survey asked about the effects on their teaching practices, their students’
and their own ratings of their teaching, their involvement in educational research and
instructional development, and their attitudes regarding various aspects of teaching and learning.
They observed that results strongly suggest: 1) NETI successfully motivated many of its
participants to adopt or increase their use of proven teaching strategies known to correlate with
improved student learning, 2) made them more student-centered, scholarly, and reflective in their
teaching practice, 3) increased their student ratings of most of them and decreased the ratings of
very few, and 4) enticed a number of them to engage in instructional development and
educational scholarship.

Although options are expanding, teaching potential engineering faculty how to teach
remains a significant issue. It was highlighted by Wankat and Oreowicz\(^11\) that engineering
graduates, in particular Ph.D.’s, need to know how to teach for both academic and industrial
careers, and that ideally education in pedagogy occurs during graduate school. The paper goes
on to point out that taking a pedagogy course and serving a teaching internship during graduate
school closely parallels the procedures used to prepare graduate students to do research. Wankat
and Oreowicz\(^12\) observe that engineering students have proven to be very reluctant to take
courses from the College of Education. Students in engineering do not subscribe in significant
numbers. Perception is that content as not relevant to engineering instruction and instruction is
done in manner outside the comfort zone of engineering students. Therefore it is probably
necessary to house courses in the College of Engineering, and to have an engineering professor
teach or co-teach the courses.

In describing programs created to improve the preparation of future STEM faculty for
their roles as educators\(^13\), a case is made for presenting common concerns in the context of
socializing process and a brief survey of the range of programs to improve preparation is given.
Two programs within the Center for Integration of Research, Teaching, and Learning (CIRTL),
sponsored by NSF, are highlighted as example programs. The intent of these programs are to
provide students with a stronger foundation in which to teach as well as to assess the impact of
their teaching and learning.

III. Evaluation of Future Faculty Development Programs

Evaluation of a specific course for engineering students can potentially be informed by
evaluation of related faculty development programs. Light, et al.\(^14\) noted that “while a
proliferation of teaching centers has sought to address the increasingly complex challenges of
teaching in higher education through faculty development programs (FDPs), and a scholarship of
faculty development has begun to flourish\(^15,16\), there has been a comparative dearth of research
looking at the impact of these programs.” They used a mixed-methods approach, comprised of a survey measuring approaches to teaching, focus reports of participants, and post-program interviews, to draw on a comprehensive four year study of a FDP designed for pre-tenured faculty in order to assess the impact of a year-long FDP on faculty approaches to teaching. All three methods elicited evidence indicating that participating faculty changed towards more student-centered practices and conceptual change/student focused approaches to teaching.

Gillian-Daniel\textsuperscript{17} observed in a review of the state of assessment of impact of future faculty development in teaching STEM that although there are reported measures of learning or skill, or measures of changes in attitudes or behaviors, specific to the time of a program, “there are only two studies to date, that the author is aware of, that longitudinally document the true success of these teaching professional development programs on graduate students and post-docs as they assume their new faculty roles and put into practice what they have learned\textsuperscript{18,19}.” Gillian-Daniel further observe that within their multi-faceted program a single course with similar content to the course be assessed in this study played an important role in preparing future STEM faculty to teach effectively. They characterized impacts of their program in the categories of:

- Mastery of broad content or concepts (e.g., increased understanding of principles of how students learn)
- Development of teaching skills and techniques
- Development of interpersonal skills (e.g. collaborative or cooperative work)
- Affective outcomes- evidence of changes in faculty/student motivations to learn, in values and attitudes about science, other attitudinal changes

DeNeef\textsuperscript{18} identified 129 alumni of the Preparing Future Faculty program (PFF) who were subsequently hired in faculty positions. The study showed that the PFF program helped participants negotiate challenging academic job markets and balance their teaching and research responsibilities. On the other hand, the study did not attempt to evaluate value or effects of pedagogical knowledge or skills gained.

Bouwma-Gerahart\textsuperscript{19} addresses the research question of “What effect does teaching related professional development during doctoral and postdoctoral (preservice) training have on the attitude, knowledge, teaching practices, and career trajectories of aspiring college/university educators in the STEM fields as they prepare for and move into their early careers?” They used a 3-year qualitative longitudinal study of participants in at least one teaching professional development program at UW-Madison; primary source of data being multiple 90-minute interviews. Impacts as reported in the interviews were categorized into five types:

- Cognitive impact (knowledge and skills);
- Affective impact;
- Impact on practice and application (including material outcomes);
- Impact on participation in networks; and
- Impact on career trajectories.

Early findings reported indicate that teaching professional development can have a substantial positive impact as participants work towards and assume their first professional roles.

Wankat and Oreowicz\textsuperscript{20} report results of a survey based study of former graduate students who had enrolled in or audited a Purdue course entitled “Educational Methods in
A forty percent response rate (42 useful surveys) was attained for a survey of ten questions each with a Likert-type scale response and opportunity for comments. In order to address the issue of “Would results obtained from their survey of the Purdue course generalize to courses on educational methods at other universities?”, the same survey was sent to 32 people thought to have been involved in the past with similar courses or workshops. They concluded that the average and Purdue rankings of topics overlap considerably and since most educational topics are similar, results from the Purdue course should generalize. They also concluded that the Purdue course has a very significant impact on the careers of students who followed academic careers. In addition the course had a positive impact on the careers of students who chose industrial careers mainly in the areas of communications and understanding interpersonal relationships.

IV. Ohio State Course Development and Description

The specific course being assessed has its roots in activities at The Ohio State University as part of the NSF Gateway Engineering Education Coalition of the early 1990’s. The College Teaching in Engineering (CTiE) course, first offered in 1996, has remained relatively unchanged in objectives and approach with modest changes in content from year to year. The brief course description is “Designed as initial preparation for instruction in professional engineering programs at the college level. Focuses on skills, strategies and issues common to university teaching in general and engineering instruction more specifically. Designed to introduce learner to pedagogical literature and research relevant to practicing teachers of engineering.”

The course has many similarities to a general course in college teaching offered by the College of Education21. However, the course put materials in an engineering context, in a format familiar to engineering students, and integrates in material more specific to engineering as outlined resources such as Teaching Engineering22. The CTiE course does not directly focus on development of teaching assistants. However, this does occur as a benefit of the course. Although offered through the Department of Food, Agricultural and Biological Engineering, participants in the course have been engineering graduates students from a broad array of majors across the college, undergraduates with experience as undergraduate teaching assistants or peer mentors in the OSU first-year engineering program, and a limited number of post-doctoral students and current faculty. The course carries three quarter credits and is graded Satisfactory/Unsatisfactory. Enrollment and audits over thirteen offerings of the course totals 318 persons. With the exception of a few engineering student participating in the Interdisciplinary Graduate Specialization in College and University Teaching, the course is strictly an elective.

The approach of this course can be described in terms of “Tactical Strategies” of Van Maanen and Schien, as quoted in Tierney and Rhoads23 and utilized by Kalish24, for understanding the ways that “the experiences of individuals in transition from one role to another are structured for them in the organization”. This structure, given the transition is from learner to teacher, is helpful in describing the rationale for the course experience and many of the activities the course includes.
From the course syllabus, the learning objectives of the course through this period of offering were:

Obj. 1 - Students will be aware of, and know how to access the body of knowledge available to assist in design and implementation of teaching/learning at the college level; e.g. be knowledgeable of key organizations supporting engineering instruction like ASEE and ABET, general publications in education, and instructional resources; e.g. Ohio State Center for Advancement of Teaching (formerly Office for Faculty and TA Development).

Obj. 2 - Students will be aware of the curriculum issues related to engineering education specifically; e.g. accreditation requirements, laboratory development and design instruction.

Obj. 3 - Students will be able to recognize the options for types of instructional approaches to engineering materials and have understanding of their appropriate application.

Obj. 4 - Students will be able to implement both a formative and summative evaluation plan for their teaching.

Obj. 5 - Students will have developed their own philosophy of teaching statement.

Format of the courses is based on one three-hour session, one evening per week for 10 weeks (academic quarter). Primary leadership has been by the study author, however selected topics are addressed by colleagues from a range of units across campus and from other Universities. The course is highly interactive, frequently using collaborative learning techniques. Formative and summative assessment is modeled throughout course and with end of term tools. Each segment (topic and presenter) is assessed independently at the end of the course. Thirty minute individual exit interviews are used in lieu of a final exam. Common interview questions include formative assessment and professional development questions such as:

What are you going to do to continue your own learning about teaching and learning?
In retrospect, if you needed to miss a session which one would it have been?

Topics of the course have varied modestly between offerings. However, they link closely to skills sets faculty are recognized to need for teaching25,26. Most of the following topics have been consistently included:

Historic Perspectives in Teaching Engineering and University Teaching
Learning Styles*
Course and Syllabus Design
Defining and Creating Learning Objectives
Teaching Design and Laboratories
Effective Lecturing*
Writing in Engineering*
Evaluation/Assessment of Student Learning*
Evaluation/Assessment of Teaching*
Teaching Teamwork in Engineering*
Humor in the Classroom
Pedagogies of Engagement - Cooperative Learning, Problem-Based Learning
Other Alternatives to Lecture – Panel Discussions, Role Plays, Guided Discussions
University Life and the New Faculty Member (Done in collaboration with College Dean)

*Elements commonly presented by other that author.
Expectations for student work have been:
Selected readings from a handbook Teaching@Ohio State\textsuperscript{27},
A micro-teaching exercise – video recorded 10-12 minute session done outside of class to a subset of peers,
Occasional short response papers both in and between classes,
Development of a Philosophy of Teaching Statement; first draft, review by professor and two peers, and revised draft by end of term, and
Exit Interview in place of final exam.

Course evaluation has included:
Post-class Questionnaires used at Various Points in Class (e.g. One-minute paper, Fuzziest Point),
University Student Evaluation of Instruction (Ten Question Summative Evaluation),
End of term instructor Designed Evaluation Form (Quality of Presentation, Importance of Topic, Suggestions for Each Course Element; Other selected questions), and
Exit Interview with Instructor (No formal record kept).

The School of Education Policy & Leadership, University Center for the Advancement of Teaching, and the Graduate School at The Ohio State University are collaborative partners in the Graduate Interdisciplinary Specialization in College and University Teaching\textsuperscript{5}. This specialization is for any graduate student interested in engaging in a rigorous, structured exploration of the theories and practice of university–level teaching, both in general and in their own discipline and to develop skills and experience that enable them as reflective, scholarly teachers as they prepare to enter the professoriate. This specialization is open to any graduate or professional student in good standing at The Ohio State University. The course “College Teaching In Engineering” is one of 12 disciplinary based course within the curriculum and required of engineering students.

V. Methods and Procedures

Development of the assessment process for this study was guided by the six-step recommendations of Bamberger, et al.\textsuperscript{28} for impact evaluations. As outlined by Van Note Chism and Szabo\textsuperscript{29} faculty development programs, and conceptually future faculty development, could be evaluated at the three levels of 1) satisfaction of participants, 2) impact of the program on the participants’ teaching practices and attitudes, and 3) impact of the program on the participants’ students’ learning. In this case, data for the first level was available in the form of end of term summative and formative course evaluations. A survey of class participants from all previous course offerings was developed to address the second level. It was not considered feasible to address the third level in this study. Institutional Review Board approval was received for each element of the study.

A. Student Evaluations

Two available forms of student evaluation for this course are a standard University Student Evaluation of Instruction (SEI) and an instructor-designed End of Term Instrument (ETI). The
SEI is summative in form, voluntary and administered by someone other than the instructor. It includes ten standard questions with Likert-type responses. Table 1 summarizes class enrollment and evaluations available over all course offerings.

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrolled</th>
<th>SEI</th>
<th>ETI</th>
<th>Year</th>
<th>Enrolled</th>
<th>SEI</th>
<th>ETI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>17</td>
<td>17</td>
<td></td>
<td>2004</td>
<td>34</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>1998</td>
<td>15</td>
<td>16</td>
<td></td>
<td>2005</td>
<td>35</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>16</td>
<td>10</td>
<td>13</td>
<td>2006</td>
<td>31</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>2007</td>
<td>28</td>
<td>26</td>
<td>7</td>
</tr>
<tr>
<td>2001</td>
<td>16</td>
<td></td>
<td>7</td>
<td>2008</td>
<td>29</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>29</td>
<td>21</td>
<td></td>
<td>2009</td>
<td>30</td>
<td>27</td>
<td>19</td>
</tr>
<tr>
<td>2003</td>
<td>27</td>
<td></td>
<td></td>
<td>Total</td>
<td>318</td>
<td>175</td>
<td>103</td>
</tr>
</tbody>
</table>

Table 1. Participation in Evaluation of Teaching.

For each element of the course, the ETI instrument asked the student to evaluate both the Importance/Relevance of the Topic and Quality/Effectiveness of Presentation on a 5-point Likert-type scale. This was then followed by an open ended comment box for each. The ETI ended with the following four questions:

1. What other topics would you like to see in this course and what would you remove to put them in?
2. Was the microteaching helpful? How could it be improved?
3. What other evaluation questions should the instructor have asked, and what are your answers?, and
4. Do you think this course will have an impact on how you think about teaching and how you will teach? If so, how?

The two most recent ETI offerings were done via an electronic course management system which seemed to increase both the percentage of the class responding and length of responses.

B. Class Alumni Survey

The second data element was that collected by a survey of past class participants (n=318) identified from class records and class rosters. These have been termed “alumni” of the class, although some were still students. Consistent with the objectives of the study, a thirty-four question survey (Appendix) was developed with the goal of assessment of the impact of the course on knowledge about and attitude toward teaching at the college level in engineering, as well as if it has had an impact on careers of the participants. Eighteen questions were directed at the assessing if the course objectives, as listed earlier, were being met. Seven questions regarding course content and exercises followed. Two questions directly addressed impact. One of these (Do you think this course has had an impact on how you think about teaching and/or how you teach?) was nearly identical to a question posed on post-class evaluation surveys and probed general impact. The other directly asked for comments regarding impact of the course on their career path. Five questions on demographics included status when enrolled in the course and current status. A final open-ended question gave opportunity for additional comments. The
survey was distributed using the survey tool Zoomerang™. A reminder was sent to non-respondents after one week. The survey was open for a total of four weeks.

Potentially correct email addresses were compiled from University records and internet searches for 311 of the students. Of the 311 individual email addresses entered into the web-based survey system, 36 were reported as undeliverable. Of these persons, alternate addresses were tried for six persons. These alternate addresses were not reported as undeliverable. Therefore it is assumed that the survey may have reached up to 281 individuals.

VI. Results and Discussion

A. University Summative Evaluation

Data is available for the end of term Student Evaluation of Instruction (SEI) questionnaire supported by the University for nine of the thirteen offerings of the course (Table 2). Average participation rate over the nine offerings was 83%. Rating scale of the form is from 1 (Lowest Response) to 5 (Highest Response) for the first ten items. Item 11 is generated from a University-wide database which picks classes for comparative characteristics based on class size (Small, Medium, Large) and electivity (Required, Free, Choose).

<table>
<thead>
<tr>
<th>SEI Item Descriptions – Instructor:</th>
<th>Means*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Well organized</td>
<td>4.8</td>
</tr>
<tr>
<td>2. Intellectually stimulating</td>
<td>4.6</td>
</tr>
<tr>
<td>3. Interested in teaching</td>
<td>5.0</td>
</tr>
<tr>
<td>4. Encouraged independent thinking</td>
<td>4.7</td>
</tr>
<tr>
<td>5. Well prepared</td>
<td>4.8</td>
</tr>
<tr>
<td>6. Interested in helping students</td>
<td>4.9</td>
</tr>
<tr>
<td>7. Learned greatly from instructor</td>
<td>4.6</td>
</tr>
<tr>
<td>8. Created learning atmosphere</td>
<td>4.8</td>
</tr>
<tr>
<td>9. Communicated subject matter clearly</td>
<td>4.8</td>
</tr>
<tr>
<td>10. Overall rating</td>
<td>4.9</td>
</tr>
<tr>
<td>11. University comparison group</td>
<td>4.6</td>
</tr>
</tbody>
</table>


Table 2. Summary of Student Evaluation of Instruction Results.

These results would indicate the course was well received by the students. However, since these questions focus on the instructor, they cannot really be used to predict impact of the course.

B. End of Term Formative Evaluation

As mentioned previously, evaluation of the course has included an instructor-designed form which queries students on the Importance/Relevance and Quality/Effectiveness (Likert-type scales) and allows for comments on each topic. Although these are useful in course improvement, the last question “Do you think this course will have an impact on how you think about teaching and how you will teach? If so how?” is of the most interest for the current work. A qualitative analysis of the responses to the impact question was done by the author by
categorizing responses into the six major categories in Fink’s Taxonomy of Significant Learning\textsuperscript{30}. The six categories and a brief definition are:

**Foundational Knowledge** – refers to students’ ability to understand and remember specific information and ideas. “Foundational Knowledge provides the basic understanding that is necessary for other kinds of learning.

**Application** – Learning how to engage in various kinds of thinking (critical, creative, practical), developing certain skills. “Application learning allows others kinds of learning to become useful.”

**Integration** – see and understand the connections between things. “The act of making new connections gives learner a new form of power, especially intellectual power.”

**Human Dimension** – discover the personal and social implications of what they have learned, self-image and self-ideal. “This kind of learning informs students about the human significance of what they are learning.”

**Caring** – degree to which student care about something, reflected in new feelings, interests, or values. “When students care about something, they then have the energy they need for learning more about it and making it a part of their lives.”

**Learning How to Learn** – learn about the process of learning itself. “This kind of learning enables students to continue learning in the future and to do so with greater effectiveness.”

An individual person’s response could result in multiple responses within a category and responses in multiple categories. Table 3 summarizes both the distribution of respondents and responses across categories. Any use of a term that indicated knowledge of a course content category was included in Foundational Knowledge.

<table>
<thead>
<tr>
<th>Significant Learning Category</th>
<th>Number of Responses*</th>
<th>Percent of Total</th>
<th>Number of Respondents in Category</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundational Knowledge</td>
<td>113</td>
<td>51.1</td>
<td>67</td>
<td>67.3</td>
</tr>
<tr>
<td>Application</td>
<td>47</td>
<td>21.3</td>
<td>43</td>
<td>42.6</td>
</tr>
<tr>
<td>Integration</td>
<td>14</td>
<td>6.3</td>
<td>13</td>
<td>12.9</td>
</tr>
<tr>
<td>Human Dimension</td>
<td>11</td>
<td>5.0</td>
<td>10</td>
<td>9.9</td>
</tr>
<tr>
<td>Caring</td>
<td>26</td>
<td>11.8</td>
<td>24</td>
<td>23.8</td>
</tr>
<tr>
<td>Learning How to Learn</td>
<td>10</td>
<td>4.5</td>
<td>9</td>
<td>8.9</td>
</tr>
</tbody>
</table>


Table 3. Categorization of Question Responses by Significant Learning Experience Category (Question: Do you think this course will have an impact on how you think about teaching and how you will teach? If so how?).

Responses to the question indicate that students were using a vocabulary that indicated considerable Fundamental Knowledge and awareness of concepts around Application of the Knowledge. Since these are students just finishing the course, it is not unreasonable to expect a predominance of responses in the first two categories. However statements across the full spectrum of the Taxonomy of Significant Learning experiences were received. Comparison of these results to those in the alumni survey is included later in this paper.
Although responses often needed to be seen in context of the full statement for classification, four representative responses for each category are included in Table 4.

<table>
<thead>
<tr>
<th>Significant Learning Category</th>
<th>Example Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundational Knowledge</td>
<td>Learning styles; Teaching philosophy; Alternative to lecture; Cooperative learning</td>
</tr>
<tr>
<td>Application</td>
<td>New skills; Approach systematically; Incorporate more; Foster ideas; Utilizing some skills</td>
</tr>
<tr>
<td>Integration</td>
<td>Different outlooks; Believe now that NOT everyone can teach; Experience better prepares; Realize various factors associated with</td>
</tr>
<tr>
<td>Human Dimension</td>
<td>More aware of how I teach; I am not the only one; Politics involved in teaching; Opened my eyes to issues</td>
</tr>
<tr>
<td>Caring</td>
<td>Importance of good; Have more appreciation; Try to learn more; Want to be a teacher</td>
</tr>
<tr>
<td>Learning How to Learn</td>
<td>Seek out guidance; Reflect on how I; I will get help from; Realize how dynamic the area is</td>
</tr>
</tbody>
</table>

Table 4. Example Responses by Category of Significant Learning Experience.

C. Survey of Course Alumni

Demographic and Description of Respondents

Within the four-week period of the survey useable response data was received from 142 individuals, representing 46 percent of the class participants and 50 percent of potential known addresses. Seventy-seven percent of the respondents voluntarily included their name.

Demographics of the respondents is shown in Figure 1. The majority of respondents were graduate students (45.6% PhD, 26.5% MS) when enrolled in the class, with an additional element of undergraduate students (16.9%). The undergraduate students were almost exclusively engaged with instruction in the first-year engineering program. At the time of responding to the survey (current) almost 31% remain in some student category. Of those moving out of student status, the largest numbers moved into faculty (23.2%) and industry (24.6%).
The following five sections summarize results is around course objectives.

**Objective 1** Students will be aware of, and know how to access the body of knowledge…

Responses to six questions most closely aligned with the first course objective are summarized in the Tables 5 and 6. Immediate impact would be implied by 68.3% reporting a change in approach to their own learning while in college. Accessing to pedagogical literature and class materials are indicated by substantial rates (59 and 64%), with 71% indicated they think they read more such materials than their peers. Discussion of pedagogy with others (83%) also appears to be substantial. A smaller but still significant percentage (37%) had used more structured university resources. Of those currently in faculty roles, 67% reported use of such support.

<table>
<thead>
<tr>
<th>Question</th>
<th>%Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did class change the way you approached your own learning while in college?</td>
<td>68.3</td>
</tr>
<tr>
<td>Have you gone back and looked at any of the material from the class?</td>
<td>63.8</td>
</tr>
<tr>
<td>Do you read education-related articles or papers?</td>
<td>59.2</td>
</tr>
<tr>
<td>Do you think you read more such articles than your peers?</td>
<td>71.1</td>
</tr>
<tr>
<td>Within the past year, have you discussed pedagogy (ideas on teaching) with colleagues or others?</td>
<td>83.0</td>
</tr>
<tr>
<td>Have you utilized any university's instructional resources (like OSU's Faculty and TA Development office)?</td>
<td>37.0</td>
</tr>
</tbody>
</table>

Table 5. Responses Related to Course Objective 1 (n=143).

Forty individuals (28%) reported one or more levels of involvement in scholarship or research related to teaching and learning. Of those currently in faculty roles, a higher percentage 18 of 33 (54%) reported being engaged.
Table 6. Involvement in Scholarship or Research on Teaching and Learning.

<table>
<thead>
<tr>
<th>Topic</th>
<th>% All (n=143)</th>
<th>% Faculty (n=33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have not had opportunity to do educational scholarship/research</td>
<td>59.4</td>
<td>45.5</td>
</tr>
<tr>
<td>Have done funded educational scholarship/research and published results</td>
<td>7.0</td>
<td>12.1</td>
</tr>
<tr>
<td>Have done unfunded educational scholarship/research and published results</td>
<td>5.6</td>
<td>12.1</td>
</tr>
<tr>
<td>Have done educational scholarship/research and presented at a conference</td>
<td>9.1</td>
<td>24.2</td>
</tr>
<tr>
<td>Have done classroom scholarship/research to improve my teaching by never published or presented</td>
<td>18.9</td>
<td>36.4</td>
</tr>
<tr>
<td>Other, please specify: Wrote a thesis for a Master's in Education degree; Will publish results and articles in coming year. My project is funded; Currently working on a funded course development.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Objective 2 Students will be aware of curriculum issues...

Responses to the question “What would you list as the top three or four curriculum issues related to engineering education today” (114 of the 143) gave a very wide range of responses with approximately 265 identifiable items. Although difficult to categorize, an emergent type coding by the author showed that the largest elements dealt with 1) curriculum issues such a depth vs. breadth, length of program, theory vs. application (hands-on), 2) faculty issues such as tenure and reward systems and staying current with field and pedagogy, 3) specific curriculum content issues of communications, teamwork, technology use, ethics and 4) concern regarding student preparation and retention of information.

Objective 3 Students will be able to recognize the options for types of instructional approaches.

Results from a pair of questions related to types of instructional approaches they preferred as a student and then how they are or have been teaching demonstrate that a gap does exist between the two (Figure 2). The largest gap occurs in the areas of active learning exercises and laboratory.
Figure 2. Instructional Approaches – Preferred as Student Compared to Current Practice.

Objective 4 Students will be able to implement both a formative and summative evaluation...

Answers to a question regarding their current use of formative and summative evaluation (n=71) imply that the question was not clear about if the request was evaluation of student performance, evaluation of teaching effectiveness or a combination. However, an array of tools introduced in the class were noted as being used within and at the end of terms. These include: mid-term and end of term surveys (standard and self-designed), journals, minute papers, fuzziest point exercises, discussion with student, and student performance on quizzes/exams/homework/etc. This question would need to be refined to get more useful information.

Objective 5 Students will have developed their own philosophy...

One of the instructor’s goals for this course is to encourage students to consider teaching engineer as a career path and to help prepare them for either formal teaching or other career paths. Their perceptions of how the course changed their career expectations or path, as well as their involvement in teaching, indicate some success in towards this goal.

When directly asked “to what extent the course experience made them more inclined to consider teaching at the college level as a career”, more than ninety percent reported a higher level of inclination after the course with 34% being very much more and 17% completely inclined. In subsequent Yes/No question, only twenty-eight percent indicated the course has an impact on their career track (Change career goals.). However in written comments, some participants did mention they were committed to teaching prior to the course and therefore did not change goals.
In regard to did the course as help to be a faculty member (Yes/No), of those that responded to that question, 98% indicated the course helped them prepare. Of those who were students when taking the course and who are faculty (n=29) 96%, all but 1, indicated Yes. When queried if the course had an impact on their search for non-academic positions, 40% indicated the course had positive impact.

When asked to comment regarding impact of the course on their career path, 82 persons gave written responses. A summary of representative comments would appear to be most useful when characterization by combinations of current statuses of the individuals (Table 7). For those still in the student or post-doc category, the course was reported to have both helped them clarify career goals and given them useful tools for instruction. For those now in University faculty roles, it was reported to have helped with job searching, as well as motivation towards and success as a faculty member. As reported by Wankat and Oreowicz\textsuperscript{11} positive impact on career path for those not going into academic careers was also indicated.

<table>
<thead>
<tr>
<th>Student or Post-doc (n=29)</th>
<th>1) Clarified career goals, more inclined towards faculty role and engineering education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>…helped me refocus and better define my career goals.</td>
</tr>
<tr>
<td></td>
<td>My current plan is to go to graduate school starting next fall, with a fairly strong possibility of one day becoming a professor.</td>
</tr>
<tr>
<td></td>
<td>It also taught me about engineering education which is now what I hope to do for my PhD!</td>
</tr>
<tr>
<td></td>
<td>2) Tools for current use/preparation</td>
</tr>
<tr>
<td></td>
<td>…it gave me some tools and insight that have made me a better instructor.</td>
</tr>
<tr>
<td></td>
<td>Regardless of your career path teaching is present. For example, even though I'd like to work for industry, I know that I would have to communicate and convince effectively what I have learned in my research. Isn't that teaching also? I'm glad I took your class.</td>
</tr>
<tr>
<td></td>
<td>Taking this course helped me feel much more prepared for applying for faculty positions (once that time comes).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>University Faculty (n=16, includes Ohio State) and Staff (n=6)</th>
<th>1) Job Search</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>This course gave me some extra credibility in talking about my plans for teaching.</td>
</tr>
<tr>
<td></td>
<td>It reinforced my desire to be a professor and to teach young minds.</td>
</tr>
<tr>
<td></td>
<td>The course convinced me I want to be at a university that emphasizes teaching.</td>
</tr>
<tr>
<td></td>
<td>2) Motivation</td>
</tr>
<tr>
<td></td>
<td>I am at a teaching focused engineering college (Rose-Hulman) in no small part due to my experience in FABE 810.</td>
</tr>
<tr>
<td></td>
<td>Got me more enthused about my career choice.</td>
</tr>
<tr>
<td></td>
<td>It did provide me with some confidence as I started down that path.</td>
</tr>
<tr>
<td></td>
<td>It helped me realize that I do enjoy teaching, and will be pursuing my interest in this area as I shape my career plans.</td>
</tr>
<tr>
<td></td>
<td>3) Success in Faculty role</td>
</tr>
<tr>
<td></td>
<td>Allowed me to develop a scholarship of teaching collaboration</td>
</tr>
<tr>
<td></td>
<td>Even though I was pretty sure I wanted to become a faculty member in my country, the course had an impact on my teaching philosophy.</td>
</tr>
<tr>
<td></td>
<td>The course gave me the opportunity to improve my teaching and facilitating ability.</td>
</tr>
<tr>
<td></td>
<td>It helped me to be a better teacher in classroom.</td>
</tr>
</tbody>
</table>

| Industry (n=13) and Government (n=4) |
1) Helpful in current role
   - In areas of new technology, you have to constantly educate others as a way to sell yourself. The information is helpful whether you will become a professor or not.
   - It is very usual in my work to have to explain a new idea or concept to my coworkers. In those cases what I learned during the course becomes very useful.
   - I have taken more of a training role within my group at work and have actively worked to change how we teach within our group (from developing new training flows to class development)

2) Hope to teach in future
   - I still think about maybe teaching in some capacity in the future.
   - I hope to have the opportunity to teach engineering in the future.

Table 7. Summary of Comments on Impact on Career Path.

Impact Question

Responses to the general question, similar to the one asked of students at the end of each class, regarding “impact on how you think about teaching and/or how you teach” are summarized in Table 8 again using Fink’s taxonomy for classification of responses. As with the previous data, Foundational Knowledge and Application were most frequent. However, as shown in Figure 3, there was one very apparent shift between the two data sets. Fundamental Knowledge as percent of responses (and respondents) decreased while Integration responses increased. However, as with the earlier data, the responses would indicate an understanding of a breadth of concepts involved in creating a significant learning experience through college teaching in engineering.

<table>
<thead>
<tr>
<th>Significant Learning Category</th>
<th>Number of Responses</th>
<th>Percent of Total</th>
<th>Number of Respondents in Category</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundational Knowledge</td>
<td>60</td>
<td>35.3</td>
<td>50</td>
<td>48.1</td>
</tr>
<tr>
<td>Application</td>
<td>40</td>
<td>23.5</td>
<td>44</td>
<td>42.3</td>
</tr>
<tr>
<td>Integration</td>
<td>35</td>
<td>20.6</td>
<td>40</td>
<td>38.5</td>
</tr>
<tr>
<td>Human Dimension</td>
<td>9</td>
<td>5.3</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>Caring</td>
<td>21</td>
<td>12.4</td>
<td>21</td>
<td>20.2</td>
</tr>
<tr>
<td>Learning How to Learn</td>
<td>5</td>
<td>2.9</td>
<td>5</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Table 8. Categorization of Question Responses by Significant Learning Experience Category – Alumni Survey (Question: Do you think this course has had an impact on how you think about teaching and how you will teach? If so how?).
VII. Conclusions

Student evaluations from the time of course offering indicated this course has been well received. Content analysis of end-of-term written responses indicated the students gained an appreciation of a broad range of topics (fundamental knowledge) but also expressed understanding of the elements needed for creating a significant learning experience.

The survey of class alumni indicated that upon later reflection, the students still valued and would recommend the course to others. The high rate of survey response could be concluded to be an indicator of continued interest in the topic. When asked if they would recommend this or a similar course to engineering students thinking about academic careers, ninety-six percent said yes. They reported using the course had increased their commitment toward teaching in engineering. An interesting immediate impact was implied by a reported change in their own approach to learning as a student. Although comparative data is not available for non-course participants, other indicators of involvement, like their reading about and discussing teaching, participating in the scholarship of teaching and learning, were at significant rates. Content analysis of written responses to a direct impact question would imply that course alumni retained considerable basic knowledge but implied more consideration to the integration of knowledge or making connections between topics in teaching and learning.

The course does appear to have positive impact on both students who move on to academic careers and those who do not. Students’ perceptions and analysis of their responses indicate they are better prepared for the teaching element of an academic career. Clearly a single course cannot be expected to fully prepare students to move into the teaching responsibilities at the College level. However it can be a valuable element in the student’s professional development for the academy. It can contribute a significant element to more comprehensive programs.
Bibliography


21. Anon. 2010. “College Teaching”, Course in School of Educational Policy and Leadership, Ohio State University, Retrieved 1-5-11 from

**Appendix - Course Alumni Survey Questions**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Response Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Name (Optional)</td>
<td>Open Comment</td>
</tr>
<tr>
<td>Q2: Did class change the way you approached your own learning while in college?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Q3: Have you gone back and looked at any of the material from the class?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Q4: Do you read education-related articles or papers?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Q5: Do you think you read more such articles than your peers?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Q6: Within the past year, have you discussed pedagogy (ideas on teaching)</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Q7: Are you currently involved with teaching engineering courses?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Q8: Are you involved in teaching outside your employment, e.g. community or church?</td>
<td>Yes, No</td>
</tr>
</tbody>
</table>
| Q9: How much have you been involved with Scholarship or Research on teaching and learning? (Pick all that apply) | 1. Have not had opportunity to do educational scholarship/research  
2. Have done funded educational scholarship/research and published results  
3. Have done unfunded educational scholarship/research and published results  
4. Have done educational scholarship/research and presented at a conference  
5. Have done classroom scholarship/research to improve my teaching but never published or presented  
6. Other, please specify                                                                 |
| Q10: Have you utilized any university's instructional resources (like OSU's Faculty and TA Development office)? | Yes, No                                                                                                                                        |
| Q11: What would you list as the top three or four curriculum issues related to engineering education today? Please list: | Open Comment                                                                                                                                    |
| Q12: Thinking of yourself as a student, what types of instructional approaches to engineering materials are/were you preferred methods? (pick all that apply) | 1. Lecture  
2. Discussion  
3. Recitation  
4. Independent Readings |
Q13: If you have been or are currently teaching, what types of instructional approached to engineering materials have you used? (pick all that apply)

- Laboratory
- Active Learning Exercises
- Team Work Activities
- Distance Learning
- Other, please specify

Q14: If you have been or are currently teaching, what forms of formative (primarily for course and teacher development) and summative (primarily for administrative purposes) evaluation did/do you use in your teaching? Please list:

- Open Comment

Q15: To what extent did the FABE 810 course experience make you more inclined to consider teaching at the college level as a career?

- Not at all
- Somewhat more inclined
- Very much more inclined
- Completely committed
- NA

Q16: Did the course impact your career track (Change career goals)?

- Yes, No

Q17: Do you feel the course helped prepare you to be a faculty member?

- Yes, No, NA

Q18: Did this course have an impact on your search for non-academic positions?

- Yes, No, NA

Q19: Would you recommend this or a similar course to engineering students thinking about academic careers?

- Yes, Maybe, No, NA

Q20: Please indicate the FIVE (5) elements of the course content you have found most useful to you?

- Historic perspectives in teaching engineering and university teaching
- Learning styles
- Course and syllabus design
- Defining and creating learning objectives
- Teaching design and laboratories
- Lecturing effectively
- Writing in engineering
- Evaluation/assessment
- Teaching teamwork in engineering
- Humor in the classroom
- Pedagogies of engagement- cooperative learning, problem-based learning
- University life and the new faculty member

Q21: Please enter any comments regarding course content:

- Open Comment

Q22: How valuable was the microteaching exercise?

- No Value
- Minimally Valuable
- Somewhat Valuable
- Very Valuable
- Extremely Valuable
- NA-Do not remember this
| Q23: How valuable was developing your philosophy-of-teaching statement? | • No Value  
• Minimally Valuable  
• Somewhat Valuable  
• Very Valuable  
• Extremely Valuable  
• NA-Do not remember this |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q24: Was your philosophy-of-teaching statement helpful to you in job searching?</td>
<td>Yes, No, NA</td>
</tr>
<tr>
<td>Q25: Do you have any recollection of a particular exercise, experience, speaker, etc. in FABE 810 which significantly impacted your teaching practice? Please elaborate.</td>
<td>Open Comment</td>
</tr>
<tr>
<td>Q26: Based on your experience do you have any suggestions for course content/topics/exercises? Please elaborate.</td>
<td>Open Comment</td>
</tr>
<tr>
<td>Q27: Do you think the course has had an impact on how you think about teaching and/or how you teach? (Please be as specific as possible.)</td>
<td>Open Comment</td>
</tr>
<tr>
<td>Q28: Please offer any comments regarding impact of the course on your career path:</td>
<td>Open Comment</td>
</tr>
</tbody>
</table>
| Q29: What was your status when you took the course? | • Undergraduate  
• M.S. Student  
• PhD Student  
• Post-Doctoral Student  
• University Faculty  
• University Staff  
• Other, please specify |
| Q30: What is your current status? | • Undergraduate  
• M.S. Student  
• PhD Student  
• Post-Doctoral Student  
• University Faculty  
• University Staff  
• Industry  
• Government  
• Not Employed at this time  
• Other, please specify, (non-profit, etc) |
| Q31: Are you a member of ASEE? | Yes, No |
| Q32: Are you member of other technical societies which support teaching? | Yes, No |
| Q33: If yes to other societies, please list. | Open Comment |
| Q34: Are there any additional comments you would like to make? | Open Comment |