



## On-Campus Faculty Discussions on Best Practices in Engineering Education

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### Abstract

South Dakota State University has a multiple-year history of providing opportunities for faculty to engage in discussions on improving their abilities in teaching and learning. Due to interest for engineering-specific topics by members of the SDSU chapter of ASEE, an on-going series of presentations and discussions was started in Spring 2011.

The ASEE Best Practices committee based their work on the findings of “Innovation with Impact”, a six-year nation-wide study of top engineering schools. One of the conclusions of that study is that engineering education innovation requires, at the least, engineering and education expertise working in continual cycles of educational practice and research.

The committee surveyed the College of Engineering faculty on their topics of interest, and decided on a format of a continuing series of one-hour sessions, led by SDSU engineering faculty. Over the last five semesters there have been twelve discussion sessions, on topics such as teaching on-line, engaging students in the classroom, rubrics, assessment, active learning, and academic quality and rigor. This paper discusses the goals of the series, what has been presented over the last two years, and what we have accomplished so far.

### Scholarship of Teaching and Learning

There has been a large change in how engineering education is practiced and viewed in the last two decades. In the past, there was not a wide-spread, systematic approach on how to train engineering faculty to teach. As Felder and Brent put it, “If you are like most university professors, you were not taught anything about how to teach in graduate school or when you began in your first faculty position. All you had to go on was how your professors taught, but nobody taught them anything about teaching either.”<sup>1</sup>

The lack of a well-researched, peer-reviewed, field of study on how to train university faculty to teach also extended to areas outside of the engineering field. Boyer helped define the terminology of scholarship about teaching, and started a broad discussion across the country, with the publication of *Scholarship Reconsidered* in 1990<sup>2</sup>. Four types of scholarship were defined:

- The Scholarship of Discovery, frontier research that increases new knowledge within a discipline
- The Scholarship of Integration, applied research that builds on and extends frontier research
- The Scholarship of Application, applied research that directly benefits society

- The Scholarship of Teaching, later renamed Scholarship of Teaching and Learning (SoTL) studies education and uses the results to improve it and involves the constant interplay of teaching and learning.<sup>2</sup>

In 1994, Felder wrote: “Consider the universal vision of the professor of the 90's. She does pioneering research in a critical area and brings in big bucks to support the research, including several six-figure NSF grants and 60% release time. She publishes 5-10 papers each year in the most prestigious journals in her field and is a shoo-in for the National Academy. She is a dedicated and stimulating instructor and wins teaching awards at her university and nationally. She does more than her fair share of the tedious but vital service chores that no one wants to do and does them excellently. She is mostly imaginary.”<sup>3</sup> In 1987 Feldman examined 42 studies and concluded that “the likelihood that research productivity actually benefits teaching is extremely small...the two, for all practical purposes, are essentially unrelated.”<sup>4</sup>

Does that mean that engineering faculty have to make a choice between what is considered typical engineering research - Boyer’s Scholarship of Discovery, Integration, or Application - or concentrate on teaching? Prince, et al.,<sup>5</sup> argues that SoTL is the means most likely to achieve a link between teaching and typical engineering research.

Boyer’s fourth definition of scholarship, SoTL, has been guiding the course of the engineering education community. There are several definitions to what SoTL is. Richlin states a scholarly teacher investigates in the literature what has been tried to attempt to solve specific teaching problems, then selects and applies a method that has the best chance of helping students achieve a learning objective.<sup>6</sup> Hutchings, et al., states that SoTL is, at its core, an approach to teaching that is informed by inquiry and evidence (both one’s own, and that of others) about student learning.<sup>7</sup> Care has to be taken that clear lines are drawn between scholarly teaching and SoTL. As Prince puts it, “if faculty members study innovative instructional methods, evaluate the extent to which the methods improve knowledge acquisition and skill development, apply the outcomes to their own courses, and publish relevant findings that can be used by other instructors to improve their teaching, it is reasonable to hypothesize that improved learning should result.”<sup>5</sup> This process may be called scholarly teaching.

SoTL can be defined<sup>5</sup> in relation to three types of knowledge that teachers may possess: (1) content knowledge - knowledge of the facts, principles and methods in the discipline that is being taught, (2) pedagogical knowledge - understanding of the learning process and the conditions that facilitate and hinder it, independent of the discipline in which the learning takes place, and (3) pedagogical content knowledge. This last term was coined by Shulman<sup>8</sup> to denote knowledge and understanding of the learning process in the context of a particular discipline. SoTL encompasses studies intended to advance pedagogical content knowledge that are made available for peer evaluation in the professional community.<sup>5</sup>

Borrego has traced the change in engineering education research from a reform paradigm to a research paradigm. While the reform paradigm stressed curricular change and improved pedagogy, the research paradigm emphasizes systematic investigations, rigorous methods, and convincing evidence.<sup>9</sup> The reform paradigm might be called scholarly teaching and the research paradigm called SoTL. More recently, the pendulum has swung back to the integration of both

reform and research efforts, especially through transforming the engineering education research agenda.

One explanation of SoTL comes from the National Research Council (NRC) in *Scientific Research in Education*.<sup>10</sup> According to this NRC report, scientific or rigorous research in education (including engineering education) should:

1. Pose significant questions that can be answered empirically
2. Link research to relevant theory
3. Use methods that permit direct investigation of the question
4. Provide a coherent and explicit chain of reasoning
5. Replicate and generalize across studies
6. Disclose research to encourage professional scrutiny and critique<sup>11</sup>

The National Science Foundation has funded engineering education coalitions that have looked specifically at teaching of engineering. One was the Center for Advancement of Engineering Education (CAEE). Their final report from 2010 states that engineering faculty need to be educators who are capable of using the research on the student experience. “This involves not only preparing tomorrow’s educators with conceptions of teaching that enable innovation but also understanding how today’s educators make teaching decisions. We also need to be concerned about creating the capacity to do such research—in short, we need more researchers. One promising approach is to work with educators who are interested in engaging in research, supporting them as they negotiate the space between their current activities and their new work in engineering education research.”<sup>12</sup> The CAEE also produced results from its Studies of Engineering Educator Decisions (SEED). They observed that engaging in research on teaching decisions has professional development benefits for the researchers who analyzed the decision narratives, the researchers who collected the narratives, and even the educators who were asked to provide the narratives.<sup>12</sup>

Another response to Boyer’s call for SoTL resulted in the National Effective Teaching Institute (NETI), which was first offered at the 1991 Annual ASEE Conference in New Orleans, Louisiana. NETI has been attended by 992 professors from 216 different schools. The NETI has motivated many of its participants to adopt or increase their use of proven teaching strategies known to correlate with improved student learning; made them more student-centered, scholarly, and reflective in their teaching practice; and induced many of them to engage in instructional development and educational scholarship.<sup>13</sup> SDSU has sent several faculty members to NETI over the last few years, an indicator of College of Engineering support for improving engineering teaching.

Studies by Boice<sup>14</sup> show that for 95% of new faculty members it takes four to five years of trial and error to become fully productive in research and effective in teaching. Boice also found, however, that the other 5% - the “quick starters”- are effective in their first one to two years, and the actions that distinguish quick starters from their colleagues can be identified and taught. That is to say, a good faculty development program can cut several years off the normal faculty learning curve.<sup>15</sup>

Hutchings states that engaging in a cycle of inquiry and improvement allows teachers to identify

and investigate questions that they care about in their students' learning. This allows them to implement this knowledge in the form of new curricula, new assessments and assignments, and new pedagogies, which in turn become subjects for further inquiry.<sup>7</sup> This cycle of improvement becomes a powerful way for faculty to grow as professionals over time. This is work that can be done independently by engineering faculty, but having the support of other faculty encourages such work. Formal faculty development centers are playing increasingly important roles in campuses across the country; they are well positioned to connect research in SoTL with educational issues of wider institutional concern.<sup>7</sup> Faculty development centers on most campuses is commonly provided by social scientists (generally education and psychology faculty members) to campus-wide audiences. Without discipline-specific examples, it is easy for engineering faculty to dismiss program content as irrelevant to their courses.<sup>15</sup>

ASEE has sponsored many long-term investigations into the state of engineering education over the years. The latest comes from Jamieson and Lohmann in 2012, *Innovation with Impact - Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*.<sup>16</sup> This was a six-year study about current education practices at major engineering schools. One of their main points is that education innovation requires engineering and education expertise working in continual cycles of educational practice and research, as Figure 1 illustrates.

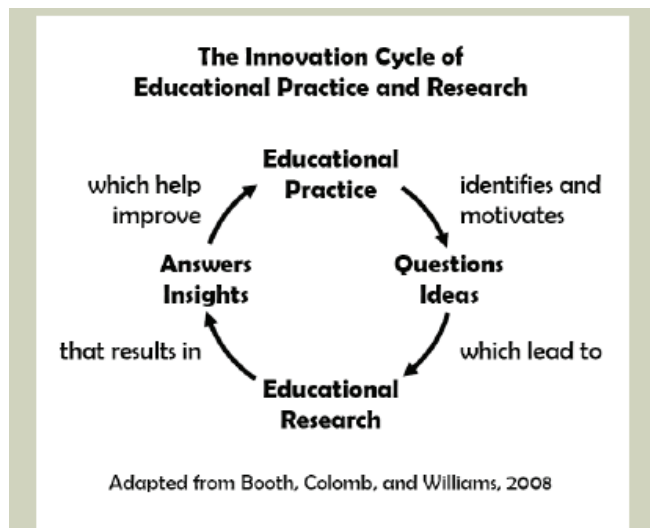


Figure 1. The Innovation Cycle, from Jamieson and Lohmann<sup>16</sup>

In the report, Recommendation 5 states: “Raise awareness of the proven principles and effective practices of teaching, learning, and educational innovation, and raise awareness of the scholarship of engineering education.”<sup>16</sup> It is with this goal in mind that the committee approaches the Best Practices in Engineering Education series.

### Best Practices in Engineering Education Sessions

Since the early-1990’s there has been a series of meetings at the SDSU campus level to ‘talk about teaching.’ These meetings were generally very informal, and covered topics across a wide range of educational subjects. Most of the sessions were guided and led by experienced faculty

from the Education or Liberal Arts fields. There was a small number of engineering faculty who would attend these meetings. In the early 2000's, a Teaching Learning Center was started for the entire campus by the Dean of Academic Affairs, and a half-time position was created and staffed by a campus Electrical Engineering professor, who retired in 2013. For several years, she stressed in the workshops and seminars SoTL as an area of research for faculty. From her perspective, SoTL involves the integration of teaching with the scholarship of research.<sup>17</sup> She further explained that for an activity to be designated as scholarship, it should manifest at least three key characteristics, derived from Shulman<sup>8</sup>: it should be public, susceptible to critical review and evaluation, and accessible for exchange and use by other members of one's scholarly community.<sup>17</sup>

In 2010, the Teaching Learning Center was emphasized even more on campus, and a regional search selected a new Director, a full-time position. The Center was given several responsibilities for training of faculty across campus. The campus website states:

The South Dakota State University Teaching Learning Center's mission is to further develop, support, and promote a culture of excellence in teaching and learning.

The TLC's goals are:

To provide faculty with professional development opportunities which foster student learning.

To develop, identify, support and disseminate teaching and learning resources.<sup>18</sup>

Formal recognition of SoTL on campus was seen in a 2011 brochure<sup>19</sup> that was published by the Teaching Learning Center. The brochure was written to bring focus to the difference between scholarly teaching and SoTL. Table 1 shows a summary from that brochure, which used Richlin<sup>6</sup> as a source.

Comparison of Scholarly Teaching + SoTL		
	Scholarly Teaching	SoTL
Anchored in literature of teaching and learning	X	X
Emphasis on documenting student learning	X	X
Teaching and learning as community property		X
Work is peer reviewed		X
Evidence of outcomes is disseminated through professional outlets		X

Table 1. SDSU Definition of Scholarly Teaching vs SoTL

The work done by the SDSU Teaching Learning Center has brought a lot of attention to SoTL and the subject of what is teaching to all campus faculty, but again, few engineering faculty

would attend the sponsored seminars and workshops. The general, informal, complaint was that the subjects covered were not of interest to engineering faculty, as Felder, et al. found.<sup>15</sup>

For several years in the annual Campus ASEE meetings, attended by a maximum of ten faculty ASEE members, the discussion focused on various ways to encourage faculty to be more involved in changes being made in the field of engineering education. These initiatives were supported by the Dean of Engineering as a worthwhile thing to do, but there was no formal initiative started. There were suggestions to do mini-conferences, bring in nationally-known speakers in the area, or have campus meetings to discuss teaching topics. Little action was taken.

At the annual ASEE Campus meeting in October, 2010, a committee was formed under the title of ‘ASEE Dissemination Group’ and given a charge to develop an engineering-education based event, which could be a seminar, workshop, or discussion. Four committee members met to make definite plans. The committee first decided that our main considerations would be that presentations should come from College of Engineering faculty, to help ensure that the topics and discussion pertain to engineering, engineering technology, math and physics, and that all presentations should include plenty of time for questions and discussion.

The committee was renamed ASEE Best Practices in Engineering Education, and the mission of the group was defined as:

- Organize engineering education-related presentations to assist College of Engineering (COE) faculty in learning about best practices in teaching and learning
- Provide a forum or platform for our own faculty who are engaged in Scholarship of Teaching and Learning, SoTL, to present their findings locally
- Provide presentations/workshops to help faculty become better informed of what it takes to participate and be fully engaged in SoTL

The committee developed a on-line survey that was sent out to all SDSU faculty members early in the Spring 2011 semester. The questions asked were:

What types of faculty development offerings would you like to see?

Presentations, Workshops, Informal Discussions, or Webpage for posting information

If workshops/discussion series are provided by the ASEE-COE committee, what is the ideal time to hold these meetings (or events)?

Morning/lunch/afternoon and day of week – may select multiple times

What is the ideal length for a faculty development activity?

Full-day, half-day, two hours, or one hour

How often would you like to see workshops?

Four, two, or one per semester

Please select topics that interest you

A list of 44 topics were presented – may select multiple topics

Forty-seven faculty (out of approximately 100 total) responded and the consensus was that they would prefer presentations, for one-hour, over lunch-time and later in the week, for one to two times a semester. The committee further decided that food and drink would be provided, paid for

by the College of Engineering Department heads in rotation. The committee sent out a follow-up email to all engineering faculty, asking for volunteers to do presentations. Several faculty volunteered, and short presentations (under 15 minutes), with a limited amount of discussion following, occurred in the three sessions in the first semester. There was great response to the topics and format, and further sessions were planned and continue to the present.

The amount of time needed to plan and carry-out the Best Practices sessions has been reasonable, once the process was started. For the last two academic years, the planning committee has met once or twice a semester, with emails in-between meetings used extensively to work out details, to plan on the direction of the sessions, to arrange dates for the semester, and to suggest and recruit faculty members to do presentations or lead discussions. The sessions have been strongly supported by the Dean of Engineering. Advertisement for the sessions happens at the beginning-of-the-semester College of Engineering meetings and through email to all engineering faculty. Over the five semesters that the sessions have occurred, there has been an average of 15 – 20 College of Engineering faculty at each session. This includes Department Heads and the Dean of Engineering, who have participated closely in the discussions. A total of 16 different faculty have presented short topics or led discussions at the sessions. The topics for the twelve sessions have been:

1. Teaching On-line – 2 faculty presentations - 2/24/2011
2. Engaging students in the classroom - 3/24/2011
3. Engineering Education research in your classroom/lab - a summary of presentations at ASEE Regional/Annual Meetings by SDSU faculty. Three presentations - 4/14/11
4. Problem-Based Cooperative Learning, a summary of Karl Smith's 1½-day workshop presented at SDSU in July, 2011 - 10/6/2011
5. Embedded Assessment: Quality Control vs. Quality Assurance - 12/1/11
6. Use of Rubrics in Assessment - 2/9/12
7. Discussion of College of Engineering collaborative project proposals for the SDSU Academic and Scholarly Excellence fund – 3/22/12
8. Collaborative project proposals – 4/12/12
9. Active Learning – 10/9/12
10. Academic Quality and Rigor – Grading. The College of Engineering portion of the campus-wide discussion – 11/13/12
11. What is Rigor and Quality? – 2/18/13
12. What is Rigor and Quality? – 3/15/13

The committee surveys the faculty attendees each time, to make sure the sessions are meeting the faculty's needs. For example, the survey from the first session on February 24, 2011, asks the attendees to answer, using a scale of 1 = Strongly Disagree to 5 = Strongly Agree:

- Presentations met my expectations
- Presentations gave me ideas on how to proceed with an online course
- Discussion was useful
- Room was comfortable

Figure 2 shows the results of the surveys over the last five semesters, for the question “Presentation (or Discussion) gave me ideas on how to (subject for that session)”. The results

indicate that the attendees are in the range of ‘agree’ to ‘strongly agree’ that they had received new ideas to use in their teaching, for all the sessions for which we did a survey. A survey has been done for nine out the twelve total sessions.

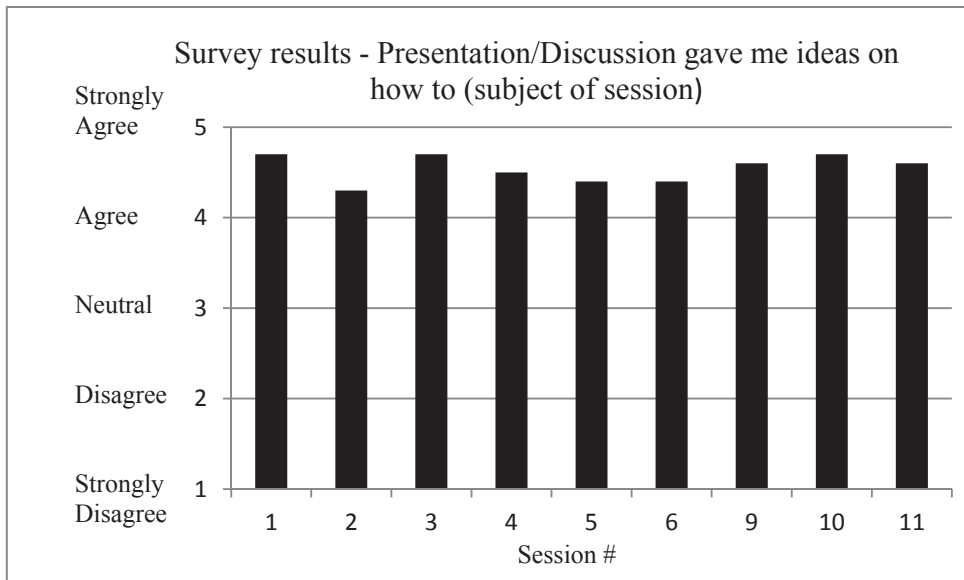


Figure 2. Five Semesters of Survey Results

### Session Summaries

The first three sessions in Spring 2011 were arranged to be like a typical ASEE Conference meeting, with more than one presenter for the hour-long session. There was a limited amount of time left for questions after the 15-20 minute presentations. The questions that came up, such as details about the presenter handled situations with on-line classes, and how engaging students in the classroom could be handled in large classes, were answered briefly by the presenters, and other faculty felt free to add in their experiences. With the limited amount of time, little true discussion took place. The third session consisted of three presentations of papers presented at the Sectional or Annual ASEE Conference, and that provided no time for questions at all. When the Best Practices Committee reviewed the semester’s sessions, it was decided that more time was needed for questions and discussions, and so only one topic would be done per session in the future, and only one or two faculty would present.

The University has been active in providing one-week-long summer workshops to groups of faculty to help them improve their teaching, mostly concerning the use of classroom technology or on-line teaching. In the summer of 2011, one workshop was attended almost exclusively by engineering faculty, and the university brought in Karl Smith for a 1½-day presentation on Cooperative Learning, among other topics. The first Best Practices session of the fall presented a Cooperative Learning exercise from Smith’s workshop<sup>20</sup>. This exercise promoted much discussion of the learning process involved. The faculty present did not all agree on how to approach the exercise presented, and the committee believes that helped faculty see that the students in their classes might have the same experience. The next two presentations, Embedded Assessment and The Use of Rubrics, were from faculty who had presented the same information



in other settings at the University previously. The topics were thought to be new to many faculty, and were considered to be mostly educational in nature. There were many questions about how to use the educational tools in specific situations. The last two sessions of the 2011-12 academic year were set aside for faculty to discuss possible topics to write proposals for the SDSU Academic and Scholarly Excellence fund. A major point that came from the discussion was that such a proposal could be used a stepping stone to be used for larger educational grant proposal. Several small groups were formed that wrote proposals for the fund dollars, but none were funded.

In the 2012-13 academic year the first session's topic was Active Learning. The presenter led the session as she would a typical class, with much free-flowing discussion of a technical topic, which appeared to be a novel approach to many of the faculty present. There were many questions asked about how this technique could be applied to other courses. For the Fall session on Grading, and the two Spring 2013 sessions on 'What is Rigor and Quality?', which followed a campus-wide set of discussions on the same subject, engineering faculty have been very open to exploring the issue via wide-ranging discussion, with only a faculty member in front of the room guiding the debate. It is gratifying to see that some engineering faculty have become more comfortable with talking about the process of teaching and learning.

An interesting pattern has developed over the past five semesters. As time has gone on faculty are more willing to engage in discussion about the many topics that have been presented. There have been no conclusions drawn on what is the 'best way' to engage students, provide active learning opportunities, assess student work, etc. Instead the sessions are chances for faculty to talk about teaching and ask questions of each other on specific situations that happen in their classrooms.

The sessions have attracted the attention of the full-campus SDSU Teaching Learning Center. They have looked at these sessions as a model for other campus departments to adopt. The Best Practices committee also presented the goals and history of the sessions at the South Dakota Board of Regents system-wide Conference on Academic Quality in 2013.<sup>21</sup>

### **Problems Remaining**

There are obstacles to overcome in having SoTL recognized as a valid route of scholarship for engineering education faculty. Research grants bring in money, which is important, and as a relatively small engineering school we have not attempted to pursue large NSF-style education grants or attempted to participate in an engineering education coalition.

As Richlin states, when a faculty member has completed a scholarly teaching process, he or she must decide whether or not to proceed with turning the findings into the scholarship of teaching. The faculty must also consider, however, whether the extra effort to write up the material, subject it to another peer review, and disseminate the resulting manuscript would be worth the time required in terms of faculty rewards. The sad truth is that many departments and institutions do not count pedagogical scholarship as part of the faculty members' scholarly production.<sup>6</sup>

At SDSU, in the Professional Staff Evaluation that each faculty fills out each year, faculty are asked to set goals for next year and review their performance from the past year, in four major areas: teaching and advising; research, scholarship, and creative activity; specific service; and general service. A certain amount of effort and output is expected in all areas, depending on the kind of appointment the faculty member has. This kind of breakdown pits one kind of work against another, and it is in the faculty member's best interest to devote their energy to the area that will bring them the greatest reward. For most engineering faculty, SoTL often falls far down the list of activities.

## Conclusion

From the Best Practices committee's perspective, the sessions that have taken place over the last five semesters have produced good results. Faculty members, who once would respond immediately when presented a new educational practice with "That will never work.", are now engaging in discussions by asking questions like "How did you do that?" and "Have you considered trying this?". For the Fall 2013 semester, the focus on the sessions will be to ask those faculty, who have done so, to present the work they have done to try to improve student learning. This could be in the form of scholarly teaching, where the faculty member attempted a new teaching method or process, and what the results were, good or bad; or their formal SoTL research, including research of proven methods, applying those methods, gathering verifiable results, and sharing the results through publications.

In 2011, Hutchings, et al., stated, "The spirit of *Scholarship Reconsidered*<sup>2</sup> remains highly relevant to the academy today. The message that there's an underlying scholarly dimension to different kinds of faculty work is particularly important at a time when many colleges and universities are appointing faculty to teaching-only positions, often not on the tenure-track, increasing the danger of further separating the roles of teaching and research. We believe that the scholarship of teaching and learning is the best way for institutions to keep the interconnections between these intellectual functions alive for individual faculty."<sup>7</sup> It is the goal of the committee to continue the Best Practices in Engineering Education sessions on our campus to keep SoTL, and the advances being made in good engineering education practice, in front of all engineering faculty.

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