A Virtual Community of Practice to Support Faculty Efforts to Adopt Research-based Instructional Approaches

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This paper describes a model for a virtual community of practice (VCP) to support faculty efforts to adopt research-based instructional strategies. The VCP was built on published recommendations for successful faculty development programs. The two leaders had expertise in the technical focus areas of chemical engineering and material science, as well as in engineering pedagogy. The participants were were full-time faculty members with a range of teaching experience and pedagogical expertise. Workshops were held using Internet conferencing software: the first 8 weekly workshops provided training in research-based pedagogy, and the second 8 biweekly workshops supported faculty efforts to implement chosen strategies in their courses. Significant improvement was measured via pre/post survey in the areas of familiarity and use of research-based pedagogy, as well as in perceived student motivation.

Keywords – community of practice, research-based pedagogy, instructional practice, online training

I. INTRODUCTION

Since 2008, the ASEE Corporate Member Council has led a stakeholder-driven process to identify and define the attributes necessary for a modern engineer to work in a global environment [1. This study and others send a clear message that we must improve the focus on fundamentals, teach more real world thinking, increase coverage of emerging areas, teach problem solving skills, offer more instruction on oral and written communications, instill in students an awareness of ethical, environmental, and social issues, and so on. These findings have significant overlap with those of that National Academy of Engineers [2] and National Science Foundation [3] as well as the outcomes sought by accrediting bodies such as ABET, IChemE, and Engineers Australia. In addition, we must not increase the total number of credits or time required to complete a degree. It is clear that these goals are not achieved by traditional engineering education, and that a major transformation is necessary to create an engineering ecosystem that supports the development of the competencies required by the next generation of engineers.

Current models of faculty development have had limited impact in transforming teaching practices in the classroom. This paper presents a model for a virtual community of practice (VCP) that supports faculty efforts to adopt research-based instructional practice in their classrooms. The model was used in a VCP for faculty teaching chemical engineering and materials science courses. The results show increases in faculty familiarity with research-based pedagogy, faculty use of research-based pedagogy, and in student motivation. The model is cost effective, time-efficient, and effective in supporting the advancement of engineering education.

II. BACKGROUND

In recent years, research on instructional practice and learning in engineering has led to a variety of teaching strategies that effectively increase student and motivation and enhance learning outcomes. These strategies are accessible to educators through a variety of mechanisms such as journals and conferences, workshops, webinars, and certification programs such as IGIP's ING-PAED International Engineering Educator certification. Yet most instructors continue to rely on traditional and ineffective teaching methods in the classroom.

Over a decade ago, Felder et al. [4] explained that the gap between the current state of knowledge and practice results from the perception and reality that good teaching is not valued in terms of career advancement. The authors made a compelling case for the need to create a positive campus climate for good teaching. Fourteen years later, we are making very gradual progress toward this goal.

Research has identified barriers that limit participation in voluntary faculty development programs. These include lack of instructor time, lack of rewards or recognition, and fear of student resistance. [5,6] Mentoring and support can help address the barrier of fear of student resistance, which is a well-understood phenomenon found to diminish rapidly when simple measures are taken to address apprehension.[7,8,9].

III. MODEL

The organization and structure of the community of practice was built on an existing knowledge base that recognizes that motivation should guide development efforts.10, 11 Specifically for this engineering and technical audience, follow recommendations of Felder *et al*.12 for successful faculty development programs were followed :

- Facilitators had expertise in both engineering and pedagogy

- Facilitators used engineering-related examples and demonstrations

- Facilitators identified and targeted the needs and interest of the participants

- Facilitators provided choices of different methods for implementation

- Facilitators modeled the recommended pedagogy during the workshops

- Participants had opportunities to practice the new content in a supported environment

- Participants were actively engaged throughout the training

The overall structure of the VCP was described by Pimmel et al. previously. [13] The two-tier structure incorporated a Leadership VCP and a Faculty VCP.

A. Leadership VCP

The leadership VCP comprised 6 weekly sessions which prepared the faculty leaders to facilitate their own VCPs. These sessions, led by Karl Smith and Cynthia Finelli, were conducted weekly and lasted approximately 1.5 hours; there were also two follow-up sessions after the faculty leaders began leading their own VCPs. The six sessions provided an introduction to the VCP and training in research-based practices of active learning, enhancing motivation, learning objectives and Bloom's Taxonomy, and student teams and cooperative learning. Final sessions focused on reflection, planning, and practice using the virtual technology. Throughout the sessions, the leaders modeled research-based instructional practice to the trainees.

B. Faculty VCP

The second tier was the Faculty VCP sessions, led by the two trained faculty facilitators and attended by faculty participants. This VCP was established for faculty teaching courses in materials science and chemical engineering. Eight sessions during the fall semester focused introducing research-based pedagogy to the faculty participants. By the end of the fall semester, the faculty participants developed and presented a plan for implementing research-based pedagogy into their spring courses. The spring semester VCP sessions were conducted approximately every two weeks, with each session being held on two different days to accommodate the schedules of all the participants. The purpose of these sessions was to provide ongoing support to the participants as they implemented the enhanced pedagogy in their courses. The format of the spring semester VCP was a faculty-driven, open-ended discussion that focused on their successes and challenges in implementing their pedagogical enhancements.

C. Participants

Eighteen participants were chosen from applicants in the fields of materials science and chemical engineering. All participants were full-time faculty members; their experience ranged from never having taught a course before and having no exposure to pedagogical methods of engagement to 20 years of teaching experience with extensive use of active learning and

teamwork. Most participants had some teaching experience but little support or modeling for implementing effective pedagogy in their classes. All participation was on a voluntary basis.

IV. TECHNOLOGY

The VCP sessions were conducted using Adobe Connect Internet conferencing software. This software allows the use of screen sharing, breakout discussions, participant polling, session recording, and a variety of other features useful for maintaining an environment of engagement and interaction. A web-based portal was also created using the Open Atrium collaborative toolkit, and this was used to post resources and facilitate asynchronous group discussion between VCP sessions.

V. IMPACT

A. Evaluation

A pre/post VCP survey was used to evaluate three areas of impact: (1) participants' familiarity with research-based pedagogical strategies before and after the VCP (2) participants' frequency of use of research-based pedagogical strategies before and after the VCP and (3) student motivation with the implementation of the research-based pedagogy. The results for the 12 faculty who completed the entire VCP cycle were used in the analysis.

B. Results

The results of the pre/post survey on familiarity with pedagogy showed significant gains in familiarity with Bloom's Taxonomy (normalized average gain 100%, $p < 0.05$), learning objectives (normalized average gain 85.7%, $p < 0.05$, active learning (normalized average gain 100%, $p < 0.05$), and cooperative learning (normalized average gain 75%, $p < 0.05$. The participants' ratings of familiarity with pedagogical strategies before and after the VCP are shown in Figure 1.
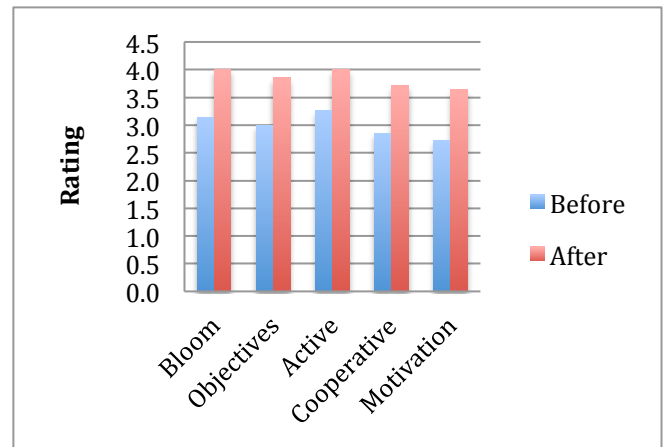

Figure 1. Faculty participants' familiarity with topics before and after the VCP. Familiarity was rated on a scale of 1 (unfamiliar) to 5 (very familiar).

The results of the pre/post survey on use of pedagogy showed significant gains in frequency of use of Bloom's Taxonomy (normalized average gain 45.8%, $p < 0.05$), learning objectives (normalized average gain 55.6%, $p < 0.05$, active learning (normalized average gain 68.2%, $p < 0.05$), and cooperative learning (normalized average gain 36.4%, $p < 0.05$. The participants' ratings of frequency of use of pedagogical strategies in their classes before and after the VCP is shown in Figure 2.
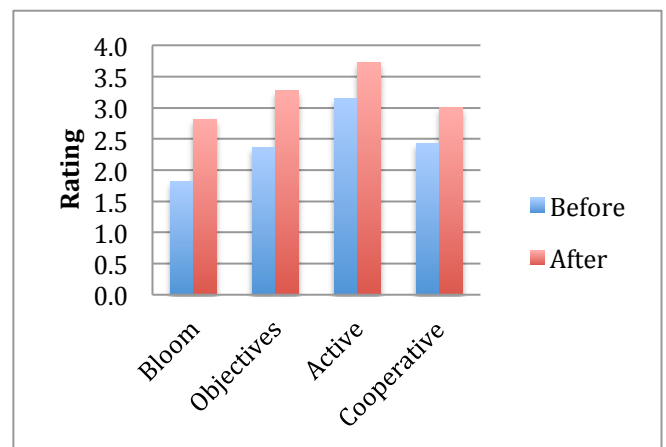

Figure 2. Faculty participants' frequency of use of pedagogical strategies before and after the VCP. Frequency of use was rated on a scale of 1 (never) to 5 (in all classes).

The results of faculty perception of student motivation were very positive. The survey asked faculty to describe student behavior in eleven areas that are closely associated with motivation. They were asked to describe student behavior prior to the implementation of enhanced pedagogy and

after the end of the course in which the enhanced pedagogy was introduced. The normalized average gain was between 36.4% and 69.7% in ten of the 11 behaviors linked to student motivation:

- students coming to class on time

- students using critical thinking

- students seeming interested in the class

- students appearing motivated to perform well in the class

- students seeking help outside of class

- students being non-disruptive in class

- student participation in class

- students' ability to apply material learned in class

- student attendance

- students keeping up with reading.

The results were perplexing with regard to the perception of student performance on exam, which showed a negative gain. One faculty member's response was eliminated because the individual informed us that exams were not used in the class this year. Some of the faculty have suggested that they gave more challenging exams because of their perception that students were achieving deeper learning. This question has not yet been explored with every member of the virtual community, but our informal analysis suggests that it may be difficult to compare exam performance between the control group and the intervention. This will be explored further through interviews with the faculty participants.

VI. CONCLUSIONS

This model of a virtual community of practice for engineering pedagogy proved to be cost effective and time-efficient for the faculty participants. The participants familiarity with and use of research-based pedagogy increased significantly throughout the VCP. The faculty perception of student motivation, based on behavioral indicators closely associated with motivation, also increased after the enhanced pedagogy was implemented. We believe, therefore, that this model provides sustainable support for the development and implementation of research-based instructional practice in engineering courses.

Our next evaluation efforts focus on student evaluation of their own behaviors in a traditional course in comparison with a course using enhanced pedagogy. The results of this study will provide a gauge of the students' perception of their motivation in the two types of courses.

REFERENCES

[1] Stephen Hundley and Lynn Borwn, The attributes of a global engineer project: updates, inputs, faculty development considerations, Proceedings of the American Society for Engineering Education 2013 International Forum, Paper 8302, Atlanta GA, June 2013.

[2] Charles Vest, , Reforming Engineering Education, National Academy of Engineers, Vol 36, No 2, 2006.

[3] Transforming Undergraduate Education in Engineering, Phase I: Synthesizing and Integrating Industry Perspectives, May 9-10, 2U13 Workshop Report, National Science Foundation, 2013.

[4] R. Felder, J. Stice and A. Rugarcia, The future of engineering education: Making Reform Happen, Chemical Engineering Education, summer 2000, p. 208

[5] C. Henderson and M. Dancy. (2007). Barriers to the use of research-based instructional strategies: the influence of both individual and situational characteristics; Physical Rev. Special Topics: Physics Ed. Res. 3:1–14. Available at ://homepages.wmich.edu/~chenders/Publications/HendersonAJPNFW.pdf

[6] Y.P. Steinert. McLeod, M. Boillat, S. Meterissian, M. Elizov and M. Macdonald (2009). Faculty development: a 'field of dreams'? Medical Education 43:42-49. Available at http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2923.2008.03246.x/abstract.

[7] R.M. Felder and R. Brent, "Navigating the bumpy road to student-centered instruction." College Teaching, 44(2), 43-47 1996.

[8] R.M. Felder, "Sermons for grumpy campers." Chemical Engineering Education, 41(3), 183-184, Summer 2007.

[9] R.M. Felder, "Hang in there: dealing with student resistance to learner-centered teaching." Chemical Engineering Education, 45(2), 131-132 (Spring 2011).

[10] R.M. Felder, R. Brent and M. Prince (2011). Engineering instructional development: programs, best practices, recommendations; Journal of Engineering Education, 100:89 –122. Available at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Instruct_Dev(JEEv100).pdf

[11] R. Wlodkowski (1999). Enhancing adult motivation to learn: a comprehensive guide for teaching all adults; 2nd ed. John Wiley and Sons.

[12] R.M. Felder., R. Brent and M. Prince (2011). Engineering instructional development: programs, best practices, and recommendations; Journal of Engineering Education, 100:89 –122. Available at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Instruct_Dev(JEEv100).pdf

[13] Russel Pimmel Ann F. McKenna, Norman L. Fortenberry, Brian Yoder, and Rocio C. Chavela Guerra, Faculty development using virtual communities of practice, Proceedings of the 2013 Annual

Conference of the American Society of Engineering Education, Atlanta, GA, June 2013.