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Faculty Development Using Virtual Communities of Practice

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A large number of reports from prestigious national organizations, for example, the National Academy's reports on the *Engineer of 2020*,[44, 45] have called for substantial changes in engineering education. Some of this urgency is due to changes in the skills and knowledge that engineering graduates need to deal with the complex, interdisciplinary nature of current engineering problems, as exemplified by the engineering grand challenges identified by the National Academy.[46] An additional factor is the change in the engineering student population; for example, the demographics, web experiences, and patience with textbooks and lectures have evolved substantially in the last few decades.[14] Finally, recent developments in learning science have shown that engaging, authentic instructional experiences enhance student learning as summarized in the *How People Learn* framework.[4]

Certainly, large-scale faculty development efforts will be necessary to accomplish these changes, but the current models for faculty development have had limited impact. The present study explores a new faculty development model that may meet the need for a sustainable, economical, effective approach to support ongoing efforts to advance engineering education. The model builds on the existing face-to-face faculty development models, on the engaging community of practice models, and on the rapidly developing web-based social networking and content management tools. It utilizes virtual communities of practice (VCP) to help faculty members understand and implement research-based instructional approaches.

The two goals of the project are: (1) to develop a sustainable VCP model for faculty development that will enable relatively inexperienced faculty members to gain an understanding of research-based instructional approaches and to implement these approaches in their classrooms and (2) to identify VCP best practices by developing approaches for characterizing the operation of VCP implementations and relating these to VCP effectiveness. This paper first summarizes the literature that underlies the VCP approach; then it describes our implementation plans and the early steps we have taken; and finally it outlines plans for collecting and interpreting evaluation data.

Background and Literature Review

In developing the rationale for the use of VCPs in engineering faculty development, we review the literature in five areas: the need for new engineering faculty development efforts, the inherent limitations of current faculty development approaches, the effectiveness of learning communities and communities of practice, the effectiveness of virtual approaches, and the participation of engineering faculty members.

Need for New Engineering Faculty Development Efforts: Many faculty professional development efforts rely on the "develop-disseminate model" in which individuals or small groups develop new curricular materials and strategies through significant effort and then try to convince others to use them.[26] The ASEE and FIE preconference workshops and special on-campus workshops based on a new curricular or pedagogical development provide examples of this model. Because these workshops typically last a few hours without any follow-up activity, they suffer from the inherent limitations of this model that are discussed in the next section.

Although the impact is limited, these types of workshops do alter the way some participants teach. For example, survey data, collected six to twelve months after faculty development workshops with a response rate of 42 %, indicated that the workshops changed the behavior of many of the respondents with 52 % of the respondents having reread the workshop notes, 54 % having read one or more related articles or website material, and 78 % having tried some implementation of the approach, although the extent of the changes and the sustainability were not discussed.[47]

Programs through campus-based centers for teaching and learning provide another mechanism for faculty development, and many of these centers offer a wide variety of programs, events, and services through a collaborative approach. However, engineering faculty members often do not take advantage of these opportunities, perhaps because they fail to see the connections between the professional development provided and the content of their courses.[66]

The more general, longer duration, disciplinary-based faculty development programs provide another model for faculty development. In engineering, the National Effective Teaching Institute (NETI) has been run since 1991.[5, 13, 14] Data from an alumni survey suggest that the NETI successfully increased the participants' awareness and use of the instructional concepts and methods treated in the workshop. For example, 98 % reported occasional or frequent use of active learning and 74 % credited NETI with a moderate or substantial role; the corresponding percentages for cooperative learning were 90 % and 65 %, respectively. The alumni indicated that NETI had an overwhelmingly positive effect on their student ratings and many participants reported activities indicative of scholarly teaching (e. g., reading publication and attending conferences).

Similar programs in other STEM fields, such as physics[25] and geoscience,[18] have been offered for some time and evaluation data show positive effects in the participants' responses. More extensive studies in other educational sectors, like medical education[60, 61,62] and K-12 mathematics and science education[21, 46] indicate that well designed professional development programs can change instructor's attitude, knowledge, teaching skills, and behavior.

However, scaling these short-term, face-to-face workshops to a level that would address the need in engineering education is problematic. For example, NETI serves at most 55 participates per year,[5] which is a small fraction of the almost 25,000 tenure-track engineering faculty members.[22] Travel support to bring participants to a face-to-face workshop, even for a couple of days becomes prohibitively expensive when the effort is scaled even to accommodate a modest number of engineering faculty members.

The inadequacy of existing faculty development models is reflected in the lack of evidence of changes in student learning,[2] the slow adoption of engaging, active-learning methods that have been systematically tested and shown to be effective,[1, 23] and the stalling of innovation in STEM education.[29] A recent systematic and fairly extensive observational study provided data indicating a reliance on the traditional lecture-based approach where instructors transmitted knowledge to students.[10] The data also showed that the most dominant teaching technique was the lecture, which was coded in 83 % of the observations, and the most predominant cognitive demand on students was receive/memorize, which was seen in 89 % of the observations.

Clearly the complexity of the higher education enterprise and the widely accepted research-based faculty reward structure and the community's limited understanding of cultural factors and change processes have slowed progress.[7, 17, 55] Significant reform will require a better understanding of these factors but, ultimately, all approaches rely on effective strategies for changing the way faculty members approach their teaching and it is not clear that the current models for accomplishing this will be adequate to enable the substantial changes in attitudes, knowledge, and skills that will be required.

Inherent Limitations of Current Faculty Development Approaches: Both the short-term workshops presenting new curricular or pedagogical material and the slightly longer, more general disciplinary workshops have several inherent limitations.

First of all, Froyd[16] noted that individuals cannot move from knowing little or nothing about a different approach to acting on acquired knowledge in a single step, and he described a sequential faculty change readiness model in which individuals move from pre-awareness to awareness to interest to search to decision to action. In the model a faculty member takes more and more responsibility to initiate action and spends more and more time seeking and acquiring additional information as he or she moves through the stages.

There have been a few studies showing the limitation of the one-time event and supporting the need for sustained interactions. Results from a faculty development effort that included introductory four-day workshops at the beginning of the academic year and bi-weekly meetings throughout the year, indicated that the latter on-going involvement was critical in changing instructional approaches.[28] Those that continued to participate reported positive changes that were not seen by those that did not continue to participate. Another study with a range of activities, found that faculty members that did not participate in the continuing interaction were not significantly different from a noninvolved control group, while faculty members that fully participated showed a statistically significant attitude change.[39]

Aside from not allowing time for sequential development, the develop-disseminate model can create an adversarial relationship between the developer and the potential adopters and, by its one-size-fits-all assumption, it neglects important local factors, such as expectations of content coverage, lack of instructor time, department norms, student resistance, class size, room layout, and time structure.[12] When others fail to adopt the material, the developers frequently infer, usually incorrectly, that the non-adopters believe that their current approaches are effective, are unaware of the research-based reforms, are focused on their disciplinary research, and are unwilling to spend time on improving their teaching. In an analogous and equally incorrect way, potential adopters typically see the developers as dogmatic, promoting a particular set of material that fits all situations; they feel that the change agents are saying that they are bad teachers and that they have not been allowed to be part of the solution. A review of the literature on K-12 teacher professional development programs also noted the limited effectiveness of the transmission model, (i. e., the develop-disseminate model) with its one-shot, one-size-fits-all, just-in-case training approaches fails to address local differences and needs.[27, 32]

In analyzing the lack of progress in higher education reform, Kezar[29] referred to this standard dissemination approach as the scale-up model of innovation diffusion where once an innovation is developed and tested, the efficacy evidence will lead to wide adoption. She notes that this approach, which has been tried extensively and unsuccessfully in K-12 education and the community-development arena, fails because the approach ignores implementation context, norms, incentives, and ownership, and she suggests two more appropriate models: learning communities and social movements. These are based on two critical assumptions: motivation is best achieved internally and innovations developed locally, or at least modified locally, create ownership, sustainability, depth of adoption and spread. Key aspects of these models are the reliance on deliberation and discussion to develop understanding of the reasons for and substance of the change and on social networks to connect people and create moral support.

Effectiveness of Learning Communities and Communities of Practice: The concepts of learning communities and communities of practice, with their sustained involvement offer a way of circumventing the limitation of the one-time, short-term workshops. These allow participants to collaborate as they share and develop their knowledge and experiences, providing them with in-depth, sustained assistance in moving to research-based instructional approaches.[10] Distinctions between learning communities and communities of practice are not straightforward but here we will focus on the latter because they tend to have a much stronger emphasis on individual implementations based on the collective knowledge that is developed by the community, that is, on practice.

Communities of practice are based on the idea of learning as social participation when people who have a common interest collaborate over an extended period to share ideas, values, beliefs, language, and ways of doing.[67, 68, 69] According to Wenger,[67, 68, 69] communities of practice have three crucial characteristics: the domain, the community, and the practice. Members have a shared domain of interest, a commitment to that domain and thus a shared competence in the domain. Secondly, members engage in joint activities and discussion, help each other, share information, build relationships, and learn from each other as a community. Finally, members are practitioners and develop a shared repertoire of resources, experiences, stories, tools, and ways of addressing recurring problems – in short a shared practice. Communities of practice are more than a collection of technical knowledge or skills, like that found in a well-managed repository. Instead they are evolving relationships developed around things that matter to the members, around a particular shared area of knowledge and activity, around a shared repertoire of ideas, commitments, and memories and around a shared set of tools, documents routines, vocabulary, and symbols.[59]

Examples of the use of communities of practice in higher education are limited but they are widely used in the business and health care sectors, although the structure, facilitator responsibility, social interactions, knowledge sharing, and knowledge creation vary widely among the implementations.[35]

In one higher education implementation, a major research university organized a year-long, interdisciplinary, on-campus faculty learning community that involved recommended readings, reflection, and individual and group activities.[33,34] Survey data indicated that participants joined because they desired to interact with other faculty, to learn what others knew and were doing, and to improve their teaching. Participants indicated that they valued their interactions with others and that they were able to relate their classroom experiences with the literature on learning; several reported changing their behavior (e. g., switching from a lecture-based to problem-based format). The two issues that came up repeatedly were protecting the meeting time and the poor fit with what the institution values.

Another research university implemented a similar program to help faculty develop the strategies and understanding of the learning process that are necessary to develop a learning centered-classroom. [28] The program offered introductory and advanced workshops and on-going biweekly meetings. It reflected the belief that faculty needed to experience learning in a learning-centered atmosphere and to practice in their own classrooms with continued support from their peers. Evaluation data showed that workshop participants that attend the regular meetings (i. e., became part of the community) reported changes is classroom behavior; while those that did not reported marginal or no progress in implementing changes in their classrooms, emphasizing the importance of continued interactions.

An extensive bioengineering curriculum development project used a community of practice framework to connect engineering faculty members and learning scientists.[31] Participants saw themselves as a group of people with a shared concern and a desire to increase their knowledge and expertise through on-going interactions. Through a structured interview methodology, they found that individuals in both disciplines grew intellectually, began reading each other's literature, learned to respect each other, and recognized each other's unique contribution and limitations.

Effectiveness of Virtual Approaches: Learning communities and communities of practice that rely on face-to-face meetings are limited to serving participants from one geographical site, for example, the two higher education examples noted above served faculty on a single campus.[28, 33, 34] In order to have a broad, general impact, these communities must serve a wider audience. Moreover, to have a specific focus, for example on a single course or small set of courses, they would need to involve participants from multiple sites. A virtual approach, where the interactions occur using the Internet, eliminates these place-based restrictions, and this technology makes the community of practice experience possible in a cost effective way to geographically dispersed individuals.[10] Use of the Internet, through a wide variety of services and tools, can overcome many of the limitation of faculty face-to-face communities of practice and enhance many of the advantages.[57]

Courter et al[11] described an on-line professional development effort involving 20 faculty members at 10 different colleges or universities. The effort included weekly conversations on readings selected by rotating facilitators, and had participants also develop and present a project. They had 100 % retention with high participation at the weekly sessions and found the delivery mode convenient, efficient, and free of technical difficulties.

Although the number of actual VCP implementations is small, a number of reports have discussed the advantages and characteristics of them for faculty and teacher development.[10, 36, 57] Early reports had more of a passive portal focus that managed vast amounts of information and linked a community easily and efficiently; whereas, later reports utilized a highly interactive implementation enabled by the evolution of the technology.

There is more literature on the effectiveness of on-line learning models for students than there is on faculty development, and the effectiveness of these supports the premise that web-based approaches can provide learning experiences for faculty participants. A large scale, systematic meta-analysis of published reports from 1996 to 2006 included only studies with random-assigned or controlled quasi-experimental designs and with objective measures of student learning, discarding studies based on perception data.[41] The study, which identified only 45 reports over all education levels from K-12 to professional educational programs, showed a statistically significant improvement in learning with the on-line students relative to the face-to-face students A second study of students in statewide community college system showed that the effectiveness of the on-line approach might depend on the students' academic preparation.[74]

A study of students' reactions and learning in a graduate-level, computer-mediated¸ mostly asynchronous course presented evidence that on-line courses can enable deep learning through the sharing of experiences and the development of a community.[3] The investigators concluded that on-line courses offer more than just time and space independence; they also provide the reflective and social environment critical for learning.

A systematic survey of *Journal of Engineering Education* articles published from 1999 to 2008 found only three articles that dealt with student collaboration and communication over the Internet.[37] One study compared performance and satisfaction of face-to-face and virtual teams in a random control experiment in a graduate course on lean manufacturing.[70] The investigators reported similar performance on the project and in the group process patterns, but the face-to-face teams were more satisfied with the experience. A second report, involving virtual and face-to-face design teams, found no difference in completion times and quality of task outcome.[30] The third article reports that first-year students that participated in a learning community, where they communicated via email and Internet conferencing, had a better understanding and confidence in the technical aspects of the design project than those that did not participate.[52]

Over the last decade, one of the authors (RP), while at NSF, has led an effort to offer a set of very well received interactive workshops dealing with proposal writing strategies, project evaluation, broader impacts, and dissemination at many national and regional meetings. A web-based version of these interactive workshops was developed and over a period of three years, 24 workshop sessions involving 6 different topics were conducted and reached over 1000 participants at more than 50 sites.[48, 53, 54] Post-workshop survey results indicate that participants agreed with statements that these interactive web-based workshops were effective and achieved the expected outcomes.

Participation of Engineering Faculty Members: Getting faculty members to engage in faculty development programs is not always straight forward and there have been a few studies in other disciplines to determine the factors that limit participation. A careful study of physics faculty identified several situational barriers including a lack of instructor time, a mismatch with department norms, and potential student resistance.[24] A similar study of medical faculty found that they valued the goals of the program but did not participate because of the volume of other work, logistic issues related to the timing and location of the activities, the lack of rewards and recognition, and the perceived lack of direction from and connection to the university.[61] A companion focus group study found that medical faculty members attended workshops because they enabled personal and professional growth, were relevant to the teacher's needs, and provided an opportunity to network with colleagues.[62] In addition, the repeat attendee valued learning and self-improvement and reported positive earlier experiences.

There is strong evidence that a substantial fraction of engineering faculty, even those at the most prestigious research universities, will participate in activities intended to improve their teaching effectiveness and to share their ideas with other faculty members, for example, approximately 4000 attend the ASEE Annual Conference while about 600 attend the FIE Conference each year. Also the participation in the preconference workshops at both of these meetings, in the NETI, and in the assorted campus-based programs indicates a willingness to engage in organized faculty development efforts. Moreover, several studies, which were cited above, indicate that some faculty members are willing to follow through on extended, even yearlong, programs.[11, 28, 31, 33, 39] Finally, the increasing interest in educational programs offered by the NSF shows a major commitment on the part of the growing fraction of the engineering education community.

Virtual events involving real-time interactive activities are a fairly new concept and participation in such events will require a new acceptance on the part of engineering faculty members. For example, a survey by a project funded to foster a virtual community of engineering education researchers through a web-based hub facility found that responders saw it primarily as a repository providing services and content rather than a real-time connection with the potential for interaction with others or an opportunity to develop a community.[64] Thus there is a challenge in getting faculty to move from an accessing information perspective to a knowledge building one in the virtual world.

Implementation Approach

In organizing the structure and content of the VCPs, we are building on the existing knowledge base. Felder et al.[14] pointed out that faculty development involves teaching adults and the work in that field, with its strong emphasis on learner motivation, should guide faculty development efforts. They suggested that Wlodkowski's five attributes of a motivating learning environment -- presenter expertise, content relevance, application choices, praxis (action followed by reflection), and group work – provide an excellent framework for faculty development efforts.[73]

Other perspectives emphasize the importance of the social construction of knowledge in faculty development because faculty members just like students, do not learn by receiving and copying impressions and information from others but rather by constructing and reconstructing shared contextually relevant concepts and models.[2] Thus, a successful effort must build shared trust, motivation, language, and goals; promote group work and team learning, and use assessment to align group learning goals and activities and to uncover tacit differences and misunderstandings. This is consistent with the presentation in the *How People Learn* framework, which emphasizes that effective learning, must deal with prior knowledge and misconceptions, must explore some subjects in depth with many examples and must integrate metacognitive skills.[4] The literature on faculty development in medical education and on teacher development in K-12 STEM fields contains analogous guidelines.[10, 49, 60]

The guidelines for engineering faculty development provided by Felder and his colleagues effectively summarize these characteristics.[5, 13, 14] These guidelines are: (1) use facilitators with expertise in both engineering and pedagogy, (2) use engineering-related examples and demonstrations, (3) target content to the needs and interests of the participants, (4) provide choices in applications of recommended methods, (5) model recommended techniques, (6) provide opportunities for formulating and practicing their own applications, and (7) actively engage participants. Our VCP implementation will adhere to these seven guidelines and we will make all VCP leaders and participants explicitly aware of them and encourage reflection on them as the VCPs evolve.

We are encouraging each VCP to consider the *Understanding by Design*[71] approach to planning for teaching and instruction. Wiggins and McTighe [71] define understanding by design as a "framework for designing curriculum units, performance assessments, and instruction that lead your students to deep understanding of the content you teach." They suggest a "backward design" of first looking at the outcomes in order to design curriculum units, performance assessments, and classroom instruction.[65] The first step is to identify what you want students to know and be able to do as a result of instruction. The second step is to determine what one would consider acceptable evidence that students have met the desired goals. The third step is to then plan instruction to align with the learning goals and assessment. At the second and third stages participants can be introduced to some of the educational theory, but equally important they can reflect on and share some of the successful practices they have used in the past. We are making sure that all leaders and participants explicitly aware of this approach and expect that several of the faculty VCPs will follow it.

In writing about virtual implementations, Coto et al. [10] noted that communities of practice's aimed at changing the participant's instructional approaches should proceed in phases. Initially, they should contain a number of formal activities to develop trust and acquire basic knowledge by exchanging ideas, experiences, and instructional strategies. Later they should focus on experiential learning with participants re-designing their practice and experimenting with their students while supporting each other, discussing problems, discovering knowledge that is valuable to share, and, in essence, changing their daily practice. As with the guidelines and the *Understanding by Design framework*, we are making sure that all leaders and participants are aware of the evolutionary nature of the VCP development.

Overall VCP Structure: The overall VCP framework is a two-tier structure with a first-level VCP (i.e., the Leadership VCP) for training the leaders of the second-level VCPs (i.e., the Faculty VCPs). We planned that each Faculty VCP would involve 20 to 30 faculty members working to develop a better understanding of research-based instructional approaches and then to support each other as they begin using these approaches in their classrooms. We planned two cycles of the Leadership-Faculty VCPs; the first started in January of 2013 and the other will start in September of 2013; each cycle will last two semesters. The website at http://www.asee.org/asee-vcp has more information on this year's VCPs.

Leadership VCP: The Leadership VCP is designed to provide the leaders of the Faculty VCPs with the knowledge, skill, and attitudes they will need to organize, lead, and facilitate their VCPs focused on specific course areas and support them as they begin working with their community. Thus leaders of the first-level VCP need to be recognized in engineering education for their expertise in research on student learning, on the implementation of research-based instructional approaches, and on the organization and operation of community-based faculty development. Dr. Cynthia Finelli and Dr. Karl Smith have agreed to lead the first Leadership VCP. Participants in the Leadership VCP will eventually become the leaders of the Faculty VCPs as discussed below.

The schedule for the first Leadership VCP is:

1/15/13	Introduction to the LVCP
1/22/13 & 1/29/13	Active learning
2/5/13 & 2/12/13	Student motivation
2/19/13 & 2/26/13	Using learning objectives and Bloom's taxonomy
3/5/13 & 3/12/13	Using student teams
3/19/13	Reflection on LVCP and identification of best practices for FVCPs

This schedule fits with the start of the Faculty VCPs around the end of March. Two to four additional Leadership VCP sessions are planned to support the Faculty VCP leaders once these session start.

Faculty VCPs: Each year we will organize five Faculty VCPs and, in the first year, four focus on instructors teaching in the circuits, mechanics, thermodynamics, and mass and energy balance areas. These areas were selected as representative of core undergraduate courses within engineering disciplines. They represent the content that is covered on the general part of the fundamentals of engineering exam and therefore, represent core content knowledge required of most engineering disciplines. We chose to structure the second level VCPs around course areas rather than cross-curricular pedagogical themes (e. g., project-based instruction, teaming and cooperative learning, teaching thorough design, service learning) because we believe that faculty members would be more interested and committed to "their courses" and that communities would develop more naturally. We did not include the first-year course and the capstone course because these typically utilize many of the research-based instructional approaches that we are trying to get adopted in the other parts of the engineering curriculum.

The remaining first-cycle Faculty VCP involves 20 to 30 participants in the National Academy of Engineering's Frontier of Engineering Education (FOEE) program working in a similar way to incorporate these approaches into whatever courses they teach. FOEE members have been selected in a highly competitive process based on their work in developing and implementing innovative educational approaches. It was formed to enable them to share ideas and learn from research and best practice in education.

The leaders of the Faculty VCPs need to be individuals that have implemented research-based approaches for improving student learning and have acquired a reputation for innovation and leadership in their course area. In identifying these individuals we examined the NSF award database, particularly the Course, Curriculum, and Laboratory Improvement (CCLI) and

Transforming Undergraduate Education in STEM (TUES) award base, as well as the engineering education literature. The leaders of the first round of VCPs are: Dr. Ken Connor and Dr. Lisa Huettel in the circuits VCP, Dr. Edward Berger and Dr. Brian Self in the mechanics VCP, Dr. John Chen and Dr. Milo Koretsky in the thermodynamics VCP, Dr. Lisa Bullard and Dr. Richard Zollars in the mass and energy balance VCP, and Dr. Mary Besterfield-Sacre and Dr. Jennifer Turns in the FOEE VCP.

In the first year, each Faculty VCP will have 10 to 25 participants. These will be faculty members that teach in the targeted course area, have indicated an interest in improving their teaching but have minimal experience in actually implementing new research-based approaches in their classes. Our purpose is to involve individuals that are sincerely interested in changing but have not already joined the "choir" in order to explore the effectiveness of the model for broad-based change. To identify these individuals we undertook a substantial recruitment effort to obtain applications from a wide range of departments and population subgroups. We contacted ASEE members, relevant department heads, engineering deans, and NSF awardees. In an effort to ensure diversity, we undertook special efforts to recruit from minority serving institutions by emailing to the PIs on all Louis Stokes Alliances for Minority Participation (LSAMP) and Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) projects and to the participants in the proposal-writing, multiday workshops held for faculty members from Minority Serving Institutions (MSIs) over the last few years.

The web-based application asked individuals to identify the courses they usually teach, to describe any reading, workshops, conferences, or other activities that they have engaged in to guide them in improving their teaching, to summarize any classroom experiences where they have tried something different in their classes, and to indicate their willingness to participate on a regular basis in the yearlong virtual effort. They also need to have their Department Head or Dean complete a web-based statement indicating their awareness of and support for the application and plans to have the applicant teach the relevant course in the next year.

Each Faculty VCP will have virtual weekly meetings at a regularly scheduled time to explore issues of student learning in their courses, to identify and implement research-based approaches appropriate for each participant, to support each other as these efforts evolve, and to define and implement strategies for continuing and expanding their VCP beyond the NSF-supported year of activities. As discussed above with the Leadership VCP, the self-organizing nature of these groups makes it impossible to define an overall plan of action ahead of time and it is likely that each will proceed along very different paths. However, as with the Leadership VCP, they will prepare a set of specific goals, a general plan for the year with more specific plans for the initial few sessions, and a tentative schedule to meet these expectations. They also will be encouraged to make the participants aware of the seven guidelines for effective faculty development, the *Understanding by Design* framework, and the evolutionary nature of these communities.[5, 10, 13, 14, 59, 71]

Focus areas for the second cycle VCPs will be selected by a systematic effort to test whether the community can generate leadership teams that have a commitment to relevant focus areas. These may be focused on specific courses or on more overarching ideas.

Technology Aspects: All VCP meeting are being conducted using the Internet conferencing software Adobe *Connect*. In addition to the weekly meeting, the VCPs interact through a web-portal that will host assigned or recommended readings, organizational information, and the participants' products. It also will provide a highly interactive component where participants can post questions or ideas and have the group engage in an asynchronous discussion about them. An ASEE technical support is managing this site, which uses the online collaborative toolkit Open Atrium.

Evaluation

The evaluation plan is structured to investigate the two complementary evaluation questions:

1. How involved and satisfied were the participants in the Leadership and Faculty VCPs?
2. What are the characteristics of the VCPs and how are these related to changes in the participants' instructional activities?

We are investigating the first question through quantitative measures based on web metrics of participation and embedded surveys to collect feedback on usefulness of the different VCPs. The following documents and data collection instruments are being used: 1) meeting agendas, meeting minutes/notes, 2) participant satisfaction survey (post Leadership and Faculty VCP), 3) participant/attendee list for all Leadership VCPs and Faculty VCPs, 4) self-report survey of faculty VCP participants that assesses faculty changes towards using research-based instructional approaches.

The second question requires qualitative measures that enable more in-depth exploration of the nature of virtual participation, and the potential impact of the VCP on faculty teaching practices. In order to characterize participation in the VCP, and potential impact on faculty teaching practices we will collect and analyze 1) course syllabi, before and after participation, 2) entries in journal logs that include faculty reflections on defining learning outcomes, and approaches to instruction and assessment, 3) course materials, and 4) follow-up interviews with a representative sample of Leadership and Faculty VCP participants.
We will take a "theory-driven approach" to evaluation in which 1) we explicate a "theory of change" and 2) investigate how the program contributes to intended or observed outcomes (i.e., what factors support and inhibit faculty changing their instructional activities).[8] The theory of change is based on Rogers's model for the diffusion on innovations.[51] This model includes the five stages shown in Table 1. We hypothesize that with successful program implementation, faculty members will go through the five stages, which parallel the three subscales on a survey we will develop to measure an outcome of the project's theory of change.

Table 1. Rogers's stages in his model for the diffusion of innovations

Stages	**Measures (self-reported, Likert scales)**
1. Awareness—Awareness of the innovation, but lacking complete information about it.	Increased awareness of research-based instruction
2. Interest—Growing interest and	Improved attitudes towards research-based

information seeking.	instruction
3. Evaluation—Decision whether or not to try innovation based on present and future situation (process may end here if negative decision).	Improved attitudes towards research-based instruction
4. Trial—Making use of the innovation. (If use does not continue, this is called "reneging" on adoption.)	Behavioral change (Adoption)
5. Adoption—Continued full use of the innovation.	Behavioral change (Adoption)

One way we will assess faculty change over time is by utilizing a repeated-measures design and have faculty members complete the survey at three different points: pre-baseline, half way through the VCP, and at the end of the VCP. Assessing change over time has been used to evaluate level of collaboration, and change in collaboration, among grantees of state and federal projects.[15] Similar to the analyses of change in grantee collaboration over time, we will analyze data on an on-going basis using descriptive statics (frequencies, and chi-square) to explore variance among the VCPs. In addition to the self-report survey data the project will also collect actual instructional "artifacts" (both pre and post) and analyze these materials for changes in teaching practices. Examples of artifacts not only include the syllabus, but also example assignments, exam questions, or other course materials such as lecture slides, lab experiments, demos, etc. Each of the artifacts will be accompanied by a brief explanation by the faculty as to why it was selected for submission. Both the artifact and accompanying explanation will be coded and analyzed to document changes in learning goals, instructional practices, and assessment methods over time, and among the different VCPs. Course artifacts and interview responses will be coded according to standard qualitative analysis procedures using rubrics that specify aspects of Rogers's model as well as findings that emerge from the data.[42, 63]

Data collection started in January of 2013 and we will have considerable data on the first Leadership VCP and early data on the first set of Faculty VCPs by summer. These results will provide a good indication of the likely success of the model and allow us to make any needed adjustments as we start the second cycle of Leadership-Faculty VCPS.

Summary

The study explores a sustainable, economical, and effective VCP model that could provide the substantial faculty development needed for the changes required in engineering education. It will determine if the VCP model will enable relatively inexperienced faculty members to gain an understanding of research-based instructional approaches and implement these approaches in their classrooms and it will identify best practices for implementing effective VCP models. A secondary affect of this effort is providing a large number of faculty members with an effective virtual learning experience, which should enable and encourage them to explore distance education in a more meaningful way.

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