Capturing the Differences Between Two Virtual Communities of Practice Models for Faculty Development

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Abstract

Faculty development is a possible pathway to inform and encourage adoption of research-based education practices into engineering classrooms. We developed a model for faculty development called a virtual community of practice. In this model we sought to engage faculty with research-based education practices, and more specifically, focus on their implementation of these practices in their courses. Two different VCP designs were utilized in our program. The first cohort (Cycle 1) consisted of faculty that were grouped based on similar courses (n = 77). The second cohort (Cycle 2) consisted of faculty that were grouped based on similar technical engineering disciplines (n = 98). We wanted to determine if there was greater adoption of research-based educational practices depending on whether the VCP was organized around certain courses (Cycle 1) or around certain engineering disciplines (Cycle 2). We developed a self-report survey using Roger's Model of diffusion of innovation to measure faculty member's awareness of, attitudes toward, and adoption of research-based educational practices. A two-way within-subjects repeated measures ANOVA was used to assess significant differences between each cycle. For Awareness, there was not a statistically significant main effect for Cycle (Λ = 0.87, $F[2,28] = 3.66$, p =0.067). However, there was a statistically significant main effect for Cycle for Attitudes (Λ = 0.61, $F[2,28] = 18.30$, p <0.01) and Adoption (Λ = 0.46, $F[2,28]$ = 29.85, p <0.01). Adoption had the greatest mean in Cycle 1. Overall, we found that Cycle 1, had significantly greater adoption of research-based education practices.

Introduction

Enhancing faculty's use of research-based education practices has been described as a possible mechanism to help students better engage with engineering content.[1] However, faculty do not readily have access to or know where to find research-based education practices, let alone the necessary time to consider how to properly implement these practices in their classrooms. Faculty development seems the obvious solution, however, even though standard faculty development models provide information on research-based practices, demonstration of how to properly implement these practices in the classroom is tenuous and generally not in the scope of the program.[2] Even though faculty members are becoming more aware of research-based education practices and value their use in their classrooms, the adoption of these research-based education practices in engineering education has not been widespread.[3] For example, Pimmel (2003) demonstrated that less than half of faculty had indicated that they made changes to their instruction after participating in a faculty development workshop. The common face-to-face workshop faculty development approach is limiting because workshops are geographically isolating,[5] adhere to a standard 'one-size-fits-all' curriculum strategy,[6] are only accessible to a small number of faculty,[7] usually require resources that faculty may not have access to (e.g., money for travel),[3] and the workshops usually are one-time experiences without any on-going interactions to support faculty's frequently difficult initial implementation efforts of research-based education practices in their classrooms. Overall, in order for faculty to really make adjustments to their classrooms, faculty development models need to change to not only engage faculty with research-based education practices, but also to aid faculty in their implementation efforts.

What does this change need to look like? One suggestion is to have faculty work alongside educational researchers or instructors to learn about research-based educational practices, ensuring that they become stakeholders in the implementation of these practices in their classrooms.[2,8] Learning communities are one option, and are especially receptive to this change strategy because they already include facets of member negotiations between faculty development instructors [9] and can be designed for more widespread diffusion.[10]

In our current work we based our faculty development model around the concept of a community of practice,[11] one type of learning community. We developed and implemented a "virtual" community of practice (VCP) model due to advances in online, Internet, and distance learning capabilities.[12-13] In our VCP, faculty learned about educational research research-based practices, and then engaged in an implementation phase in an online setting. During the VCP, the participating faculty served as the community and network of support for each other, especially during the critical and challenging initial practice stage. We designed two different VCP cycles – one where the VCP was formed around particular courses (e.g., mechanics, thermodynamics, etc.) and one where the VCP was formed around particular technical engineering disciplines (e.g., mechanical engineering, chemical engineering, etc.) This paper presents results regarding the differences in implementation between the two cycles.

Virtual Community of Practice

A VCP is a learning community of practice that meets in a virtual setting. In a community of practice, the members of the community interact, sharing and negotiating their ideas, values, beliefs, language, and ways of doing for their common practice (e.g., instruction).[11] Wenger (1998) describes three main characteristics of a community of practice; that participants are engaged in a *joint enterprise,* are *mutually engaged* in the topic, and create a *shared repertoire* through their engagement activities. Joint enterprise and membership occur as members negotiate what their enterprise entails through sustained mutual engagement in the practice. Their shared repertoire that emerges is an amalgamation of their experiences in the topic such as resources, stories, tools, and expertise on addressing recurring problems. Over time, the community develops through the interactions of its members around, in our case, instruction. Communities of practice are advantageous in faculty development because they provide a mechanism for faculty to engage with other faculty around their shared instructional interests, and have been demonstrated to encourage faculty to learn about and utilize new education practices.[5]

Communities of practice typically occur face-to-face (e.g., on a particular university campus - see Layne et al., (2002)). So even though use of a community of practice model is beneficial for faculty development, the use of research-based education practices are limited to the geographic area where the practice exists, not unlike faculty development workshops. To overcome the geographic limitations inherent in typical communities of practice, one approach has been to enable the community to engage using the internet, or virtually. Aside from the crucial aspect of online communities meeting in a virtual setting to develop their practice through collaboration without the limitations of travel cost (time and money),[10] they have other key features not indicative of face-to-face or co-located communities. They are typically designed top-down, members do not typically know each other, leadership is chosen or recruited, communication is generally through the use of computers, development of the community takes time, and they require technological support for effective community.[14] These communities, therefore, require a fair amount of planning and organizing. Finding the right way to organize these communities would be informative and beneficial for future faculty development endeavors.

Despite the virtual setting, the community of practice formed is a learning community, leading to the same promotion of learning as the face-to-face community.[14] The efficacy for VCPs for faculty development have been demonstrated in the literature.[10, 15-16] Specifically, use of a VCP has led to faculty reports of willingness to change their instructional approaches because of their VCP experience.[17] Overall, the demonstrated efficacy of VCPs makes them a viable option for faculty development.

Our VCP

We developed a VCP faculty development model that was aimed at enabling faculty members to engage with research-based educational practices and to provide support for each other in a community setting as they implemented some of these practices in their classrooms. We had a two-tier structure: the first-tier community (Leadership VCP, or L-VCP) engaged two co-leaders for each one of the second-tier communities (Faculty VCP, or F-VCP). Each F-VCP was first exposed to research-based instructional practices (knowledge-building phase), and then they guided one another in their implementation efforts (practice phase). Additional information about the development of the VCP model can be found in.[12-13]

VCP Cycles Two cycles of the VCP were carried out. Both cycles occurred over two academic semesters. Cycle 1 began in March of 2013 and ended at the close of the 2013 fall semester. Participants in Cycle 1 were organized into four groups depending on the courses they taught: Mechanics, Thermodynamics, Electric Circuits, or Mass and Energy Balance. Cycle 2 began in September of 2013 and ended at the end of the 2014 spring semester. Participants in Cycle 2 were organized into five different groups based on their engineering technical discipline: Chemical/Materials Science Engineering, Civil Engineering, Computer Science and Engineering, Electrical Engineering, and Mechanical Engineering. Each Cycle, their associated F-VCP group, and their associated number of participants can be found in Table 1. Attendance averaged around 60% for all cycle groups.

Table 1
F-VCP Participant Break-Down

	Participants (N)	
F-VCP Group	Cycle 1	Cycle 2
Electric Circuits	22	

Mass and Energy Balance	10	
Mechanics	26	
Thermodynamics	19	
Chemical Engineering		17
Civil/Environmental Engineering		19
Computer Engineering		24
Mechanical Engineering		18
Electrical Engineering		20
Total(n)	77	99

Note: Participants attended at least one meeting

VCP Organization Each VCP cycle followed the same schedule. In the first semester weekly meetings were held for F-VCPs to (a) learn about and discuss issues of student learning and implementation of research-based educational practices in their courses, and (b) plan the implementation of the research-based educational practices appropriate for each participant. In the second semester of each cycle, F-VCP participants met on a semi-regular basis to support each other as they carried out their newly planned research-based educational approach in their course. Different research-based educational practices were covered and discussed in each F-VCP, at the discretion of the community leaders. Greater detail can be found in Authors (2016).

F-VCP participants collaborated and developed their communities of practice using web-based synchronous and asynchronous communication tools. Each group met virtually using Adobe® Connect™ (Adobe Systems, San Jose, CA) and shared resources through Open Atrium 1.0 (Phase2 Technology, 2011) web portal. More information about the synchronous and asynchronous communication tools can be found in Authors (2013) and Authors (2016).

Research Question

Two different approaches were utilized between the two cycles, prompting the question: which approach is more effective? More specifically, *we wanted to know if there were any significant differences between the two cycles regarding F-VCP participants understanding and implementation of research-based education practices.* We framed our research question using Rogers' (2003) diffusion of innovation framework.

The diffusion of innovation framework[18] is a step-wise process through which innovations (in our case, research-based educational practices) are ultimately adopted by users (F-VCP participants). The five-stage diffusion of innovation process can be outlined as follows:

1. *Awareness*- The faculty member is aware of the innovation, but is uneducated about it.
2. *Interest* - The faculty member is interested in the innovation and is making efforts to gain more knowledge about it.
3. *Evaluating* - The faculty member debates whether or not to try the innovation.
4. *Trial* – The faculty member tries the innovation in their classroom.
5. *Adoption* – The faculty member has tried the innovation, and intends on continuing to use it.

To summarize, this framework can be used to describe how faculty learn about and engage with research-based education practices, and ultimately utilize them in their courses. This framework has been used to assess the implementations of advances in research-based educational practices in engineering (see Borrego et al. (2010)). We wanted to capture possible differences between Cycle 1 and Cycle 2 regarding faculty's use of and implementation of research-based education practices along the five steps of the diffusion of innovation framework.

Method

Participants

Faculty engaged in the F-VCPs consisted of 77 participants from 67 US institutions in Cycle 1 and 99 participants from 73 US and three international institutions in Cycle 2. Each cycle was comprised of men and women, Caucasians, Asians, and Black/African Americans, and included individuals from all academic ranks up to department chair, which was only represented in Cycle 1. The complete demographic break-down can be found in Table 2.

Table 2
Demographic Data

	Cycle 1 *n(%)*	Cycle 2 *n(%)*	Combined *n(%)*
Gender			
Male	54(70%)	60(61%)	114(65%)
Female	23(30%)	39(39%)	62(35%)
Ethnicity			
Caucasian	54(70%)	59(60%)	113(64%)
Asian	11(14%)	24(24%)	35(20%)
Black/African American	6(8%)	5(5%)	11(6%)
Two or more ethnicities	0(0%)	3(3%)	3(2%)
Did not report	6(8%)	8(8%)	14(8%)
Academic Rank			
Assistant Professor	36(47%)	46(47%)	82(47%)
Associate Professor	20(26%)	26(26%)	46(26%)
Full Professor	14(18%)	12(12%)	26(15%)
Instructor/Lecturer	6(8%)	15(15%)	21(11%)
Department Chair	1(1%)	0(0%)	1(1%)

Data Sources and Analysis

Research-Based Education (RBE) survey Rogers' (2003) model of diffusion of innovation was used to construct a self-report survey to measure faculty members' awareness of, attitudes toward, and adoption of research-based educational practices. The five stages of innovation were combined to form three different stages for diffusion of innovation (Awareness, Attitudes, and Adoption). The RBE survey asked respondents to rate their level of agreement to 20 statements using a Likert-like scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Four survey items assessed awareness (e.g., "I am aware of the 'think-pair-share' teaching strategy"). Seven items assessed attitudes and interest in the "Attitudes" subscale (e.g., "A goal of instruction should be to change students' conceptions"). Nine items assessed evaluation and adoption in the 'Adoption' subscale (e.g., "In my classes students often work on group projects"). Psychometric data can be found in Authors (2016)

Analysis The RBE survey was distributed to all F-VCP participants at three different time points, once at pre-baseline (**pre** - prior to the start of the F-VCP), once at the mid-point of the F-VCP (**mid** - after the first semester), and once at the conclusion of the VCP (**post** - after the final semester). Participants missing data from any of the three time points were list-wise deleted. Nine original composite variables were created for each survey respondent (using average pre-baseline, mid-point, and conclusion for 'Awareness' items, 'Attitudes' items, and 'Adoption' items. A one-way repeated measures ANOVA was conducted for each cycle in order to see if there were any differences between the three time points for each of the three facets of the diffusion of innovation model represented in the RBE survey. No significant difference was observed between pre-baseline and mid-point data for the 'Awareness', 'Attitudes', and 'Adoption' composites. Therefore, additional composite scores were generated, averaging pre-baseline and mid-point for the 'Awareness', 'Attitudes', and 'Adoption' items. This final set of six composite variables (pre and post 'Awareness', 'Attitudes', and 'Adoption') were used to run a two-way within-subjects repeated measures ANOVA to assess significant differences between each cycle related to awareness, attitudes, and adoption of research-based educational practices.

Results

Descriptive statistics for each of the six variables are provided in Table 3. Across all diffusion of innovation variables, the means increased between the pre and post measurements. Generally, Cycle 1 was more Aware and had higher scores for Adoption of research-based education practices, whereas Cycle 2 had more positive Attitudes toward research-based education practices Adoption had the greatest mean in Cycle 1, whereas Attitudes had the greatest mean in Cycle 2.

Table 3
Descriptive Statistics

	Mean		Standard Deviation	
Variable	Cycle 1	Cycle 2	Cycle 1	Cycle 2
Awareness (Pre VCP)	3.55	3.38	0.69	0.54
Awareness (Post VCP)	4.2	4.02	0.32	0.39
Attitudes (Pre VCP)	3.38	3.81	0.32	0.22
Attitudes (Post VCP)	3.96	4	0.45	0.32
Adoption (Pre VCP)	3.81	3.47	0.39	0.36
Adoption (Post VCP)	4.19	3.71	0.39	0.43

Three two-way within-subjects analysis of variance was conducted to evaluate the effect of VCP design on use of research-based education practice for each stage of Roger's (2003) diffusion of innovation model. The purpose of these analyses was to determine if there were significant differences between cycles and between time (pre and post) for each diffusion of innovation variable. The dependent variables were Awareness ratings, Attitudes ratings, and Adoption ratings. The within-subject factors for each two-way ANOVA were Cycle with two levels (Cycle 1 and Cycle 2), and Time with two levels (pre and post). The Cycle and Time main effect, and Cycle X Time interaction effect were tested using the multivariate criterion of Wilks's lambda. Results are reported for each two-way within subjects ANOVA (Awareness, Attitudes, and Adoption).

For Awareness, there was a statistically significant main effect for Time ($\Lambda = 0.30$, $F[2,26] = 59.57$, $p < 0.01$), but not a statistically significant main effect for Cycle ($\Lambda = 0.87$, $F[2,26] = 3.66$, $p = 0.07$), or a statistically significant Cycle X Time interaction effective ($\Lambda = 1.0$, $F[2,26] = 0.01$, $p = 0.93$). For Attitudes, there was a statistically significant main effect for Time ($\Lambda = 0.37$, $F[2,28] = 47.74$, $p < 0.01$) and for Cycle ($\Lambda = 0.61$, $F[2,28] = 18.30$, $p < 0.01$), and a statistically significant Cycle X Time interaction effect ($\Lambda = 0.65$, $F[2,28] = 14.97$, $p < 0.05$). For Adoption, there was a statistically significant main effect for Time ($\Lambda = 0.56$, $F[2,27] = 21.58$, $p < 0.01$) and for Cycle ($\Lambda = 0.46$, $F[2,27] = 29.85$, $p < 0.01$), but not a statistically significant Cycle X Time interaction effect ($\Lambda = 0.97$, $F[2,27] = 0.82$, $p = 0.37$).

Two paired sample t tests were conducted to follow up the significant interaction for Attitudes. We controlled for familywise error rate across these tests by using Holm's sequential Bonferroni approach. Pairwise comparisons for Attitudes between the cycles in the pre time condition were significantly different ($t(28) = -0.49$, $p < 0.01$), but not in the post time condition ($t(28) = -6.70$, $p = 0.63$).

Discussion

Data support that the grouping models used to form the F-VCPs had different outcomes in the awareness-adoption continuum for use of research-based educational practices by engineering faculty. For both Attitudes and Adoption, there was a difference between each cycle and from pre to post. In contrast, there was no difference in Awareness between cycles, albeit both cycles showed a difference in Awareness from the start to the end of the VCP intervention. In Cycle 1, participants had higher ratings for Adoption overall, whereas for Cycle 2, ratings were generally higher for Attitudes. Cycle 1, which was organized around specific engineering courses, demonstrated higher adoption ratings of research-based education practices by the end of the VCP intervention.

Additionally, when digging deeper, the significant interaction effect of Time and Cycle for attitudes was in the pre time condition, but not in the post condition, whereas for Adoption, significant differences were seen between the cycles in both the pre and post condition. Thus, even though we see a difference between the cycles related to Attitudes, the impact of the VCP cycle on Attitude ratings is unclear, and could just be an artifact of the Attitudes differences the participants brought to each cycle prior to the start of the VCP. Additionally, the lack of interaction between Cycle and Time for Adoption indicates that both Time and Cycle impacted Adoption ratings. Therefore the VCP was likely leading to the Adoption of research-based education practices by the faculty, and even more so in Cycle 2.

Cycle 1 was specifically designed to bring together faculty that had a shared interest in a particular course. Therefore, F-VCP participants engaged in Cycle 1 were directly working with faculty that were also in the midst of teaching that particular class – possibly creating a stronger shared repertoire related to research-based educational practices in their class rooms. As faculty went about implementing new educational practices in their courses, they could discuss success and failures, and provide each other direct, timely feedback about their efforts. Cycle 2 was designed to bring together faculty that had a shared interest in teaching within a particular technical domain of engineering. Give the broader scope of the technical domain, it is possible that Cycle 2 participants perceived that the shared repertoire was not specific enough, making the implementation and ultimate adoption of research-based education practices more challenging. Due to these differences, it is possible that Cycle 1 F-VCPs may have formed stronger communities of practice than F-VCPs in Cycle 2, which in turn may explain why participants in Cycle 1 had higher Adoption ratings. However, additional research is needed to look at what differed between the two cycles regarding the community of practice they formed, and the level of support that participants provided each other in their implementation efforts.

One major limitation exists for this study. We had less than half of each cycle fully participate in the RBE survey. This relatively low response rate for the RBE surveys indicates that even though we saw some interesting trends, additional work is needed to better understand what these differences are, and offer more evidence for the presence of differences for the awareness of, attitudes for, and adoption of research-based educational practices. Additional data from the participants would possibly offer more confirmation of our findings.

Overall, our data provides preliminary evidence to support framing faculty development models around courses because it may lead to higher adoption rates of research-based educational practices in engineering classrooms.

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