A Study of Evidence-Based Practices in a U.S. University: Lessons for Faculty Development

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Abstract

This study uses Rogers' diffusion of innovation theory to interpret data on the implementation of evidence-based practices (EBPs) at a small private university in the United States. A survey was administered to STEM faculty that probed their awareness and adoption of EBPs, instructional goals, and satisfaction reaching those goals. Faculty interviews and focus groups were also conducted. The survey found that faculty were not satsified that instructional goals were being met, thus creating the pre-requisite reason to change teaching. Faculty became aware of EBPs primarily through interpersonal networks, and the decision to use them relies on their compatibility with the course, complexity of the EBP, and cultural considerations. Decisions to adopt EBPs and resultant implementation varied by gender and faculty status. Observations indicated faculty often underreported use of EBPs, and interviews indicated that faculty were less able to describe student behavior in the class than their own. Finally, confirmation of the decision to adopt varied by discipline and use was more consistent in those that had increased discussion about and training in teaching methods. Based on these findings, we have identified some key features of the adoption of EBPs that can be used for designing future faculty development. Supported by NSF #1347234.

1. Introduction

Although evidence-based practices (EBPs) for improved teaching and learning in science, technology, engineering, and mathematics (STEM) are widely studied, many faculties have not adopted them. In order to better understand the patterns and rates of EBP implementation, this study examines faculty beliefs and practices through surveys, interviews, focus groups, and classroom observations. Results were interpreted through Roger's diffusion of innovation theory with the goal of proposing strategies for supporting increased and more effective use of EBPs. [1]

2. Methods

The faculty survey examined (1) perceived importance and achievement of instructional goals in introductory STEM courses, (2) awareness and use of EBPs, and (3) factors that influence awareness and adoption of EBPs. The survey (n = 25, 75% response rate) was administered to all faculty teaching first and second year biology, chemistry, mathematics, and physics courses at a small, private university. We verified and further explored faculty perspectives through individual interviews (n = 13) and a faculty focus group (n = 5). Additionally, we conducted classroom observations in 186 class periods of 41 different courses using the Classroom Observation Protocol for Undergraduate STEM (COPUS) [2]. Statistical analysis of data was completed with SPSS.

3. Results and Discussion

Results are interpreted and discussed following Rogers' diffusion of innovation theory, which describes five stages for adopting an innovation:

1. Knowledge: become aware of the innovation and how it functions
2. Persuasion: form an attitude toward the innovation
3. Decision: choose to adopt or reject the innovation
4. Implementation: put the innovation to use
5. Confirmation: seek reinforcement of the decision to use the innovation.

Rogers also states that prerequisite to this process is a need or a problem that drives the change [1]. Newsome et al. further state that in educational settings a pedagogical dissatisfaction must exist for reform to occur [3].

3.1 Instructional Goals

Survey questions asking about instructional goals reveal that faculty are less satisfied that goals are being met compared to their importance. Specifically, 18 of 25 faculty report lower satisfaction with the goal being met than its importance for problem-solving (Wilcoxon signed-rank test, $z = 3.206$, $p < 0.0005$), 21 for conceptual understanding ($z = 4.122$, $p < 0.0005$), and the findings for student appreciation of the discipline were more mixed with only 11 of 25 feeling less satisfied compared to its importance ($z = 2.818$, $p = 0.005$). Because faculty rated satisfaction of meeting goals significantly lower than their importance, we have identified a critical issue that provides the prerequisite need to drive change.

3.2 Knowledge of EBPs

Of 32 different EBPs identified in STEM educational literature, individual faculty members were aware of 21 methods on average. A greater percent were aware of EBPs compared to a national survey of physics faculty (see Table 1) [4], perhaps because this is a teaching-focused institution.

Table 1. Knowledge of select EBPs as a percentage of respondents compared to a national physics survey.

Method	*Current Study*	*Dancy and Henderson [4]*
Demonstration	88	45
Cooperative Learning	72	49
Active Learning Problem Sheets	72	34
Modeling	56	33
Just-in-Time Teaching	52	48
Context Rich Problems	52	30
Think-Pair-Share	48	--
Ranking Tasks	40	39
Jigsaws	40	--
Mini-labs	40	--

Faculty also ranked the importance of various sources for learning about EBPs. Interpersonal interactions were most important, with 87% identifying colleagues at their own institution as being important/very important, 52% colleagues at other institutions, 61% conferences, and 52% workshops. In contrast, publications (44%), websites (48%), and webinars (17%) were less important.

3.3 Persuasion and Decision about EBPs

Rogers suggests that both the compatibility and complexity of the innovation affect its adoption [1]. In the survey, faculty were asked about a variety of factors, which we then sorted into Rogers' categories (see Table 2).

Table 2. Importance of different factors on adoption of EBPs.

Category	*Factor*	*Percent Responding as 'Important' or 'Very Important'*
Compatibility	Time it takes in class	96
	Evidence of its impact on student learning	92
	Class size	79
	Student resistance	54
Complexity	Access to ready-to-use materials	87
	Ability to easily incorporate	79
	Time to prepare	79
	Resources (funding, technology)	67
Culture	Value of student-active pedagogy within department	46
	Effect on teaching evaluations	42
	Peer support	33
	Value of student-active pedagogy within university	27
	Importance in tenure & promotion decisions	17

The two most significant factors for adopting EBPs were compatibility issues: the amount of class time required (which 96% of faculty rated as important or very important) and class size (79%), both of which can be categorized as issues of compatibility. This is consistent with responses to an open-

ended question about barriers to adoption in faculty interviews. Over a quarter (29%) of interviewees spontaneously brought up the time active learning methods take in class, and 57% mentioned class size.
The complexity of the teaching practice was important in the decision-making process. Faculty are more apt to adopt a teaching method if it is easily incorporated into the course, has readily accessible materials, and takes little time to prepare.
Although not described by Rogers, other studies have shown that educational culture, such as peer support, department climate, and institutional structure, are important in the decision to adopt a teaching practice [4, 5]. However, only up to 46% of faculty rated factors related to culture as important or very important, with the exception of access to resources.
Notably, there were significant differences among respondents based on demographics. Women identified complexity and cultural factors as being more important than men—being able to easily incorporate the practice ($U = 49$, $p = 0.018$), access to ready-to-use materials ($U = 30$, $p = 0.030$), and the time it takes to prepare ($U = 21$, $p = 0.005$), as well as the importance in tenure and promotion ($U = 22$, $p = 0.014$). Additionally, newer faculty (< 10 years) rate cultural factors as more important than experienced faculty - impact on teaching evaluations ($H(3) = 12.896$, $p = 0.0005$), the importance in tenure and promotion ($H(3) = 9.523$, $p = 0.023$), and value of student-active pedagogy within the department ($H(3) = 10.489$, $p = 0.015$) and university ($H(3) = 10.875$, $p = 0.012$).

3.4 Implementation of EBPs

In the survey, faculty were asked to identify which EBPs they currently used in lower-level STEM courses. Of 32 EBPs, 94% were reported to be used by at least one faculty member. The most widely used methods were those that can be combined with traditional lecture, while those that require course transformation (e.g., hybrid, flipped, and service learning) are reported used the least (see Table 3). This is consistent with other studies [5] and with our findings above identifying complexity as an issue to consider in adoption of EBPs. On average, eight methods were used in each course, but responses ranged from two to 18 methods.

Table 3. Use of methods in lower level STEM courses.

Method	*Relative Use**	*Method*	*Relative Use**
Lecture	100	Writing-to-Learn	31
Interactive Lecture	91	Case Studies	25
Think-Pair-Share	83	Peer-Led Team Learning	25
ConcepTests	64	Brainstorming	25
Whole Group Discussion	64	Computer-Aided Learning	20
Context Rich Problems	62	Jigsaws	20
Active Learning Problem Sheets	61	Clickers	20
Cooperative Learning	58	Ranking	20
Team-Based Learning	53	Student Presentations	20
Just-in-Time Teaching	50	Tutorials	19
Modeling	43	Hybrid Learning	10
Problem-Based Learning	42	Games	10
Inquiry-Based Learning	41	Debates	5
Demonstrations	41	Flipped Learning	5
Mini-Labs	40	Service-Learning	0
Simulations	33	Role Play	0

*****Relative use: the percentage of faculty members who use a method compared to the number who know about the method.

Examination of the relationship between instructional goals and adopted EBPs reveals a disconnect. For example, of faculty who ranked problem-solving as a ‘very important’ course goal, 13% had never heard of or knew little about problem-based learning (PBL), and only 38% who reported awareness of PBL also reported using it.
Since accuracy of self-reported data is a concern, classroom observations were also conducted. We found that faculty often underreported use of EBPs, such as clickers, discussions, and demonstrations.The agreement between faculty interviews and classroom observations was also examined. Interestingly, faculty are better at describing their own behavior (70% with the highest rating on an agreement rubric and no faculty at the lowest rating) than what students are doing in their courses (60% highest rating of agreement and 20% lowest).

3.5 Confirmation of Evidence-Based Reforms

Confirmation of change, in this case seeing others adopting EBPs, can reinforce adoption. In our study, confirmation varied by academic discipline. Six of the 32 different EBPs examined in the faculty survey had significantly different rates of current use by discipline, supporting the idea that different disciplines have signature pedagogies.

Although survey results indicate that the individual physics and biology courses employ a higher number of EBPs, other fields employ a wider diversity of EBPs across courses (e.g., 25 different methods are used in chemistry and biology compared to only 17 in physics). Physics had a high of 41% of adopted methods being used by everyone in the department, compared to only 4% for chemistry and mathematics. Within chemistry, two faculty members use between 15 and 17 EBPs while four use between four and six, which means that students in different sections of the same course have much greater variability in their learning experience. This was confirmed by examining the deviations in codes collected during teaching observations. Physics was found to have the lowest deviation in coding, while mathematics had the greatest variability. This is likely reflective of the department culture. Not only is physics education research arguably more mature than that in other areas, faculty in our physics department attend teaching workshops held by their national organization, which provides a common experience for all faculty members. Interpersonal networks are known to play a key role in the diffusion of innovations, and the similarity among members of the network is also important [1]. Homophilious networks have better communication, while heterophilious networks have a greater influx of new ideas. As demonstrated in the faculty focus groups, teaching methods are often discussed in the physics department, leading to a homophilious network and greater consistency in the number and type of teaching methods.

3.6 Implications for Faculty Development

Based on these findings, we make the following recommendations for faculty development:

1. Identify a need for change by reflecting on satisfaction that goals are being met in the classroom. (pre-requisite)
2. Use interpersonal methods of educating faculty about EBPs. (knowledge)
3. Consider the compatibility of the method with the course, and scaffold to reach the instructors' desired level of complexity. (persuasion)
4. Target select audiences to consider their specific cultural concerns. (persuasion)
5. Conduct observations to identify and confirm faculty and student behaviors. Having faculty consider courses from students' perspectives may be a segue for faculty development. (implementation)
6. Reflect on agreement between choices of EBPs used and instructional goals. (confirmation)

References

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