Growing the intention to adopt educational innovations: An empirical study

David M. Bourrie
University of South Alabama, Mobile, AL, USA
L. Allison Jones-Farmer
Miami University, Oxford, OH, USA
Chetan S. Sankar
Auburn University, Auburn, AL, USA

Recommended citation:
Bourrie, D. M., Jones-Farmer, L. A., & Sankar, C. S. (2016). Growing the intention to adopt educational innovations: An empirical study. Knowledge Management & E-Learning, 8(1), 22–38.
Growing the intention to adopt educational innovations: An empirical study

David M. Bourrie*
Department of Information Systems and Technology
University of South Alabama, Mobile, AL, USA
E-mail: dbourrie@southalabama.edu

L. Allison Jones-Farmer
Department of Information Systems and Analytics
Miami University, Oxford, OH, USA
E-mail: farmer12@miamioh.edu

Chetan S. Sankar
Department of Aviation and Supply Chain Management
Auburn University, Auburn, AL, USA
E-mail: sankacs@auburn.edu

*Corresponding author

Abstract: In order for the Open Access (OA) to learning concept to have a wider impact in formal education, it is important that faculty members intent to adopt new educational innovations. However, little is known about which variables influence the intention of faculty members. Therefore, the purposes of this study are to empirically determine: 1) which of the characteristics of the educational innovation significantly influence the intention to adopt educational innovations, 2) which variables influence the readiness of faculty members intention to adopt educational innovations, and 3) how the characteristics of the innovations moderate the relationship between faculty readiness and intention to adopt the innovations. Participants of this study include 335 faculty members in ABET certified computer science and electrical engineering programs in the United States. The results show that ease of use is positively related to the intention of faculty members to adopt an educational innovation. We conclude that Open-CourseWare developers need to ensure that ease of use is emphasized in the CourseWare and they need to propagate these initially in institutions where faculty members have positive attitude to the CourseWare and care about student learning. In addition, a new method of identifying, building, and funding “open access grant” universities that develop easy-to-use educational innovations, make them available on an open access platform, and spread them widely by embedding agents in community colleges, schools, and other educational institutions is essential. Such an initiative may lead to wider adoption of MOOCS and other open access materials.

Keywords: Intent to adopt; Educational innovations; Readiness; Faculty members; Open access to learning

Biographical notes: David M. Bourrie is an Assistant Professor of Information Systems in the School of Computing at the University of South Alabama. He
conducts research on information technology capabilities, innovation diffusion and dissemination, health information systems, and how information technology can improve decision making and performance.

L. Allison Jones-Farmer is the Van Andel Professor of Business Analytics at Miami University. She develops practical methods for analyzing data in industrial and business settings. She is currently on the editorial board of Journal of Quality Technology, and enjoys developing innovative curricula and teaching analytics and statistics.

Chetan S. Sankar is the Harbert College of Business Advisory Council Professor of Management Information Systems at Auburn University. He is the Director of the Geospatial Research and Applications Center and conducts research on experiential learning, innovations in pedagogies, and challenges in dissemination of innovative educational practices.

1. Introduction

The United Nations University (UNU) is an early proponent of open access to knowledge and identifies several challenges in developing the UNU OpenCourseWare portal (Barrett et al., 2009). One of the important challenges is how to increase the intent to adopt Open Educational Resources presented in the portal by the faculty in different departments. This article notes that compared with the total number of universities, many academies do not yet fully subscribe to the notion of ‘openness’ in the use of educational materials.

The National Science Foundation (NSF) has funded the development of many educational innovations used in Science, Technology, Engineering & Math (STEM) classrooms today, for example course management systems and research-based instructional strategies and likes these to be made available in an ‘Open’ format. Unfortunately, most of the innovations do not seem to be widely used in United States classrooms (Schwab & Sala-i-Martin, 2013). This may, in part, be due to the current reward systems that are in place for faculty members that values research over teaching (Walczyk, Ramsey, & Zha, 2007). Most faculty members, except for an occasional workshop, are not exposed to pedagogy and are expected to teach with little to no training on how students learn (Loftus, 2013). Traditional lectures with PowerPoint slides are still used in the majority of STEM classrooms in the United States (Macdonald, Manduca, Mogk, & Tewksbury, 2005; Singer, Nielsen, & Schweingruber, 2012; Walczyk, Ramsey, & Zha, 2007).

Advances in the information technology and educational innovations continually inundate educators with new hardware, software, methods, and techniques that need to be evaluated to figure out whether or not they will be adopted in the classroom. Educators have a unique set of personal values, motivators, organizational policies and alliances that influence their intent to adopting educational innovations (Gillard, Nolan, & Bailey, 2008). Faculty members at institutions where student course evaluations play a role in the assessment of their teaching may be reluctant to try new, research-based teaching approaches if they expect that those approaches will lead to critical evaluations (Singer, Nielsen, & Schweingruber, 2012). Gillard, Nolan, and Bailey (2008) note that some educators lag behind in adopting educational innovations and find that they have become pawns in the change process, vainly resisting the inevitable, while those on the front end of the adoption curve have eagerly embraced their role as change agents.
Research regarding the intention to adopt educational innovations is underdeveloped and becomes even more critical as the society widens open access to learning and education (Fairweather, 2008; Hazen, Wu, & Sankar, 2012). Intention to adopt an innovation is an important antecedent to the adoption and routine use processes (Ajzen, 1991; Fishbein & Ajzen, 1975; Hardgrave, Davis, & Riemenschneider, 2003; Taylor & Todd, 1995). Dancy and Henderson (2010) assert that several current approaches to disseminating educational innovations fail to robustly support faculty members in their intention to adopt these innovations. Hazen, Wu, and Sankar (2012) identified several characteristics of educational innovations, faculty adopters, and the environment that influence the intention to adopt innovations. Bourrie, Cegielski, Jones-Farmer, and Sankar (2014a; 2014b) used a Delphi study to identify the readiness variables of faculty members, administrators, and students that influence the intention to adopt an innovation (Hazen, Wu, Sankar, & Jones-Farmer, 2012; Rogers, 2003). Research by Taylor and Todd (1995) and Hardgrave, Davis, and Riemenschneider (2003) have empirically indicated that characteristics of innovations are direct antecedents to intention to adopt an innovation. In the organizational change literature, Armenakis, Harris, and Field (1999) suggested that receptivity to change is a direct antecedent to intention to adopt a change. In education literature, the readiness of faculty members toward educational innovations has been shown to relate to the successful intention to adopt educational innovations (Clarke, Ellett, Bateman, & Rugutt, 1996; Heywood, 2006).

There is a wide variety of educational innovations available in the engineering disciplines and funding is available from NSF to develop, disseminate, and propagate these innovations in an open format (NSF, 2015). But, if the faculty members who develop the innovations don’t know how the characteristics of an innovation and the readiness of faculty members interact to influence the intention to adopt that innovation, their dissemination and propagation efforts may not be successful (Bourrie, Sankar, & Jones-Farmer, 2015; Hardgrave, Davis, & Riemenschneider, 2003; Hazen, Wu, Sankar, & Jones-Farmer, 2012; Taylor & Todd, 1995). Therefore, the goal of this paper is to study these relationships by surveying faculty members from ABET certified computer science and electrical engineering departments. Section II discusses the research model and hypotheses. The research methods and measures are discussed in Section III. In Section IV, the results of our analysis are given. Section V discusses our findings and implication for researchers and educators. Finally, Section VI discusses the limitations and opportunities for future research in this area.

2. Research model and hypotheses

2.1. Research model

The research model (Fig. 1) was formulated by identifying the variables that comprise the characteristics of educational innovations and readiness of faculty members and relating them to the intention to adopt an innovation (Bourrie, Cegielski, Jones-Farmer, & Sankar, 2014a; 2014b). Intention to adopt is defined as whether an individual, if given the opportunity, would adopt an innovation in the foreseeable future (Teo, Wei, & Benbasat, 2003).

Rogers’s (2003) diffusion of innovation theory initially identified five characteristics of innovations (relative advantage, compatibility, complexity, trialability, and observability) that influence the adoption of innovations. Moore and Benbasat (1991), Karahanna, Agarwal, and Angst (2006), and Compeau, Meister, and Higgins (2007)
refined and expanded the characteristics of innovations. We include several characteristics of educational innovations important to the intention to adopt process, including *relative advantage, ease to implement, ease of use, and adaptability* (Bourrie, Cegielski, Jones-Farmer, & Sankar, 2014b).

**Fig. 1.** The research model

Readiness of faculty members reflects faculty members’ beliefs, attitudes, and intentions regarding the extent to which educational innovations are needed and the organizational capacity to successfully disseminate educational innovations (Armenakis, Harris, & Mossholder, 1993; Bourrie, Sankar, & Jones-Farmer, 2015). This study includes five of the most important faculty readiness variables identified by Bourrie, Cegielski, Jones-Farmer, and Sankar (2014b): receptivity to change, care about student learning outcomes, attitude to innovation, awareness of innovations, and motivation to innovate.

In the organizational change literature, *receptivity to change* is a complex multi-order construct that is synonymous with the concept of readiness for change (Armenakis, Harris, & Mossholder, 1993; Bartlem & Locke, 1981; Waugh, 2000; Waugh & Godfrey, 1993). In education literature, Clarke, Ellett, Bateman, and Rugutt (1996) defined receptivity to change as one’s internal attitudes that precede the behaviors that one takes when adopting or resisting change. Drawing from both the organizational change literature and the education literature, we expanded the broad concept of *receptivity to change* to include openness to change, discrepancy, appropriateness of change, efficacy of faculty members toward change, support by principals to change, and valence as the key indicators of receptivity to change.
2.2. Hypotheses

We derive the hypotheses based on the relationships postulated by the research model (Fig. 1).

H1: There is a positive relationship between characteristics of educational innovations (i.e., (a) relative advantage, (b) ease to implement, (c) ease of use, and (d) adaptability) and intention to adopt educational innovations.

H2: There is a significant relationship between the readiness of faculty members (i.e., (a) openness to change, (b) discrepancy, (c) appropriateness of change, (d) efficacy of a faculty member towards change, (e) support by principals to change, (f) valence, (g) attitude to the innovation, (h) awareness of the innovation, (i) care about student learning outcomes, (j) motivation to innovate) and intention to adopt educational innovations.

In diffusion of innovation research, Rogers (2003) suggests that dissemination is moderated by the environment and culture in which the dissemination is taking place. Hazen, Wu, Sankar, and Jones-Farmer (2012) proposed that characteristics of the adopter and characteristics of the dissemination environment moderate the dissemination process. Therefore, we hypothesize.

H3: The readiness of faculty members (i.e., (a) openness to change, (b) discrepancy, (c) appropriateness of change, (d) efficacy of a faculty member towards change, (e) support by principals to change, (f) valence, (g) attitude to the innovation, (h) awareness of the innovation, (i) care about student learning outcomes, (j) motivation to innovate) will moderate the relationship between the characteristics of the innovation and intention to adopt educational innovations.

3. Methods

The empirical data for this study was gathered using a survey questionnaire developed specifically to test these hypotheses. Each survey participant was asked to describe and then classify an educational innovation as either a curriculum development, development of faculty expertise, instructional material, instructional strategy, or other type of educational innovation. The faculty members perceived that these educational innovations were ‘open’ and available for faculty members to adopt them. The researchers analyzed these responses and classified them as either as candidates for ‘open access’ or otherwise. For example, if the respondent mentioned that they worked with an educational game, it was classified as a candidate for open access, whereas, if the respondent mentioned a community based learning project, it was not classified as candidate for open access. Participants were asked a series of questions related to the characteristics of the innovation they described and their intention to adopt this educational innovation.

3.1. Items in the survey questionnaire

The items in the questionnaire were based on measures validated by earlier literature; some of the items were modified to suit the requirements of this research. The characteristics of educational innovations were measured using a seven-point Likert scale where “1 = strongly disagree” and “7 = strongly agree”. Relative advantage was assessed using Compeau, Meister, and Higgins’s (2007) eight-item scale. Ease to implement was measured using the four-items ease of adoption scale by Di Benedetto, Calantone, and
Zhang (2003). Ease of use was measured by the 6-item scale by Compeau, Meister, and Higgins (2007). Adaptability was measured by the seven-item scale developed by Guilabert (2005) to measure perceived customization. Openness to change was measured using the eight-item scale by Miller, Johnson, and Grau (1994). Discrepancy, appropriateness of change, support by principals to change, and valence were measured using 18 items from Armenakis, Bernerth, Pitts, and Walker’s (2007) Organizational Change Recipients’ Beliefs (OCRBS) assessment tool. Change efficacy was measured using the six-item measure by Holt, Armenakis, Feild, and Harris (2007). Attitude to innovation was measured by the four-item scale developed by Agarwal and Prasad (1999). Awareness of innovations was measured by the six-item scale developed by Compeau, Meister, and Higgins (2007). Care about student learning outcomes was measured using the five-item scale developed by Hall, George, and Rutherford (1979) and Hall and Hord (2006) that is part of the Concerns-Based Adoption Model. Motivation to innovate was assessed using the five-item scale by Alpkan, Bulut, Gunday, Ulusoy, and Kilic (2010) called performance-based reward systems. Intention to adopt was assessed using a three-item scale by Teo, Wei, and Benbasat (2003).

The questionnaire also assessed demographic characteristics of the participants. Five items were used as control variables (gender, nationality, department, tenure status, and percentage of teaching load) in this study since prior research has shown them to affect the intention to adopt the innovations (Froyd, Borrego, Cutler, Henderson, & Prince, 2013; Henderson, Dancy, & Niewiadomska-Bugaj, 2012). Because the use of a single source for gathering information may artificially inflate the correlations among the variables, Richardson, Simmering, and Sturman (2009) suggested using a marker variable to account for this common method bias. The inclusion of the marker in a questionnaire allows a researcher to capture this spurious correlation and, if significant, attenuate the correlation among the study variables according to this marker correlation. We adapted the four-item scale by Miller and Chiodo (2008) and created an item called attitude toward the color green as a marker variable. This resulted in creation of a 116-question survey.

3.2. Sample
The sample for this study included faculty members at ABET certified computer science and electrical engineering programs in the United States. The data were collected from 336 participants (8% of those contacted) who completed the survey.

3.3. Statistical analysis
Hierarchical linear regression analysis was used to analyze the study data and test the hypotheses. To aid in interpretation of potential moderating effects, we used mean-centered scale averages for all the independent variables and intention to adopt (Cohen, Cohen, West, & Aiken, 2003). Variables were introduced to the model in four successive steps. In the first step of the analysis (Model 1), control variables were entered in the model. In the second step of the analysis (Model 2), the four characteristics of educational innovations were added to the model as predictors of intention to adopt. In the third step of the analysis (Model 3), only the significant items identified in the second step were retained and the readiness of faculty members variables were added to the model. In the fourth step of the analysis (Model 4), the significant main effects identified during the second and third steps were retained and added to a series of interaction terms
(consisting of the cross products of the significant items identified in Model 2 and significant readiness of faculty members variables identified in Model 3).

4. Results

The faculty members described 55 curriculum development innovations, 10 development of faculty expertise innovations, 89 instructional material innovations, and 199 instructional strategy innovations, which were not mutually exclusive. The researchers classified fifty-nine percent of these learning technology innovations (198 out of 335) as candidates for open access to learning and Massive Open Online Courses (MOOCS). Examples of these open access technology innovations chosen by the respondents in the questionnaire are:

- **Online learning systems:**
  - Use web resources for learning materials in lieu of textbooks
  - All class notes put on web
  - Flip class on algorithmic problem solving
  - Use Prezi
  - Video maker for YouTube

- **Intelligent tutors**
  - Online review quizzes
  - Use Gradiance which creates and administers class exercise.
  - Online tutors
  - Project Euler as a source of practice problems
  - Use WebWork to assign online homework

- **Collaborative training tools**
  - Have student from two classes teach each other on parallel computing
  - Collaborative learning where seniors grade juniors’ papers
  - Studio based learning
  - Peer reviews of projects
  - Learning by discovery in digital logic design

- **Learning with mobile devices**
  - Use tablet computer to record lectures which then put on web
  - Conduct projects on mobile devices using open source software
  - Use applets on transmission lines
  - Use iPython to do mathematical manipulation
  - Use Smartphones for programming courses
  - Mobile devices for online learning

- **Educational software and games**
  - Remote lab experience
  - Integrated automatically generated static and dynamic software visualization into introductory course
  - Multimedia case study and smart scenarios
  - Gamified learning approach
  - Use virtual machine software

- **Simulation systems**
  - Annotate animated slides
  - Teach intro to computer programming with humanoid robots
  - Use Mathematic symbolic equation solving and graphics for electromagnetic problems
  - Simulation in project management
Knowledge Management & E-Learning, 8(1), 22–38

- Use High Tech Tools & Toys lab
- Standards and web services to support learning
  - Allow faculty to share files and folders using a server
  - Use Microsoft OneNote as the mandatory option of note taking in class
- Authoring tools
  - Develop new labs using Labview
  - Use open source Real-Time Operating Systems (RTOS) for lab exercises

Some of these innovations are to be performed by students individually, others in teams in a collaborative format; others require faculty to work together; a few require administrative mandate; some provide students option to adapt the content to fit their learning styles; a few require use of mobile devices; others require playing games and simulations; and some use machine intelligence to grade homework.

Table 1 gives the demographic information on our sample. It shows that 85% of the respondents were male, 70% were White Caucasian, 57% were tenured, and for 65% of them, teaching accounted for more than half their responsibilities. Table 2 presents the Cronbach’s alphas, means, standard deviations, and correlations among the variables included in this study. The Alphas were above 0.7 indicating that the items coalesced together to represent the variables reasonably well. There was no correlation between the marker variable and other variables, signifying that there was no common method bias.

### Table 1
Sample demographics

| Demographics          | Respondents |   |   |
|-----------------------|-------------|---|---|
|                       | Frequency   | Percent |   |   |
| **Gender**            |             |         |   |   |
| Male                  | 282         | 84.18%  |   |   |
| Female                | 53          | 15.82%  |   |   |
| Total                 | 335         | 100.00% |   |   |
| **Nationality**       |             |         |   |   |
| White Caucasian       | 237         | 70.75%  |   |   |
| Asian                 | 61          | 18.21%  |   |   |
| Other Nationalities   | 37          | 11.04%  |   |   |
| Total                 | 335         | 100.00% |   |   |
| **Department**        |             |         |   |   |
| Computer Science      | 136         | 40.60%  |   |   |
| Electrical Engineering| 180         | 53.73%  |   |   |
| Other                 | 19          | 5.67%   |   |   |
| Total                 | 335         | 100.00% |   |   |
| **Tenure status**     |             |         |   |   |
| Tenured               | 193         | 57.61%  |   |   |
| Tenure-track but not yet tenured | 69 | 20.60% | | |
| Non-tenure track or no tenure system | 73 | 21.79% | | |
| Total                 | 335         | 100.00% |   |   |
| **Job Responsibility**|             |         |   |   |
| Teaching accounts for 50% or more of my responsibilities | 220 | 65.67% |   |   |
| Teaching accounts for less than half my responsibilities | 115 | 34.33% |   |   |
| Total                 | 335         | 100.00% |   |   |
Table 2
Correlation Matrix

| Variable                                | Cronbach's alpha | Mean | s.d. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  |
|-----------------------------------------|------------------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1. Relative advantage                   | .84              | 5.30 | .92  | .68 | .75 | .68 | .75 | .68 | .75 | .68 | .75 | .68 | .75 | .68 | .75 | .68 | .75 | .68 | .75 |
| 2. Ease of implement                    | .75              | 4.09 | 1.35 | .62 | .75 | .62 | .75 | .62 | .75 | .62 | .75 | .62 | .75 | .62 | .75 | .62 | .75 | .62 | .75 |
| 3. Ease of use                          | .91              | 5.08 | 1.18 | .84 | .91 | .84 | .91 | .84 | .91 | .84 | .91 | .84 | .91 | .84 | .91 | .84 | .91 | .84 | .91 |
| 4. Adaptability                         | .90              | 5.08 | 1.10 | .80 | .90 | .80 | .90 | .80 | .90 | .80 | .90 | .80 | .90 | .80 | .90 | .80 | .90 | .80 | .90 |
| 5. Openness to change                   | .91              | 5.62 | .87  | .75 | .91 | .75 | .91 | .75 | .91 | .75 | .91 | .75 | .91 | .75 | .91 | .75 | .91 | .75 | .91 |
| 6. Discrepancy                          | .86              | 5.48 | .99  | .75 | .86 | .75 | .86 | .75 | .86 | .75 | .86 | .75 | .86 | .75 | .86 | .75 | .86 | .75 | .86 |
| 7. Appropriateness of change            | .87              | 5.96 | .77  | .66 | .87 | .66 | .87 | .66 | .87 | .66 | .87 | .66 | .87 | .66 | .87 | .66 | .87 | .66 | .87 |
| 8. Efficacy of faculty members' toward change | .87              | 5.66 | .91  | .80 | .87 | .80 | .87 | .80 | .87 | .80 | .87 | .80 | .87 | .80 | .87 | .80 | .87 | .80 | .87 |
| 9. Support of principal to change       | .87              | 4.78 | 1.15 | .75 | .87 | .75 | .87 | .75 | .87 | .75 | .87 | .75 | .87 | .75 | .87 | .75 | .87 | .75 | .87 |
| 10. Valence                             | .74              | 5.60 | .93  | .66 | .74 | .66 | .74 | .66 | .74 | .66 | .74 | .66 | .74 | .66 | .74 | .66 | .74 | .66 | .74 |
| 11. Attitude to innovation              | .91              | 5.75 | .99  | .85 | .91 | .85 | .91 | .85 | .91 | .85 | .91 | .85 | .91 | .85 | .91 | .85 | .91 | .85 | .91 |
| 12. Awareness of Innovation             | .86              | 4.10 | 1.35 | .77 | .86 | .77 | .86 | .77 | .86 | .77 | .86 | .77 | .86 | .77 | .86 | .77 | .86 | .77 | .86 |
| 13. Care about student learning outcomes| .81              | 4.99 | 1.20  | .75 | .81 | .75 | .81 | .75 | .81 | .75 | .81 | .75 | .81 | .75 | .81 | .75 | .81 | .75 | .81 |
| 14. Motivation to innovative            | .85              | 3.92 | 1.34 | .75 | .85 | .75 | .85 | .75 | .85 | .75 | .85 | .75 | .85 | .75 | .85 | .75 | .85 | .75 | .85 |
| 15. Intention to adopt                  | .88              | 6.06 | 1.00 | .75 | .88 | .75 | .88 | .75 | .88 | .75 | .88 | .75 | .88 | .75 | .88 | .75 | .88 | .75 | .88 |
| 16. Attitude toward color green         | .72              | 3.72 | 1.06  | .75 | .72 | .75 | .72 | .75 | .72 | .75 | .72 | .75 | .72 | .75 | .72 | .75 | .72 | .75 | .72 |

Note: N = 335. * p < .05  ** p < .01

Table 3 presents the results of the hierarchical linear regression analysis with intention to adopt educational innovations as the dependent variable. In the first step, (Model 1), we found the control variables were not significantly related to intention to adopt. In the second step (Model 2), we found that none of the control variables significantly related to intention to adopt once we added the characteristics of the educational innovations to the model. Significant relationships were found for relative advantage (H1a, b = .23, df = 322, p < .001) and ease of use (H1c, b = .23, df = 322, p < .001). Hypotheses 1b and 1d, which posited a significant association between ease to implement and intention to adopt educational innovations, was not supported. Hypothesis 1d, which posited a significant association between adaptability and intention to adopt educational innovations, was also not supported.

In the third step of the hierarchical regression analysis (Model 3), relative advantage and ease of use were retained and the readiness of faculty members’ variables were added to the model. Four out of the ten hypotheses regarding readiness of faculty members’ variables were empirically supported. Significant and positive relationships were found for efficacy (H4d, b = .21, df = 314, p = .004), valence (H4f, b = .20, df = 314, p = .007), attitude towards the innovation (H4g, b = .22, df = 314, p = .002), and care about student learning (H4i, b = .11, df = 314, p = .002).
### Table 3
Results of Analysis

| Variables                          | Model 1 | Model 2 | Model 3 | Model 4 |
|------------------------------------|---------|---------|---------|---------|
|                                    | b | se     | b | se     | b | se     | b | se     |
| Constant                           | 0.06  | (0.12) | 0.06  | (0.10) | 0.07  | (0.09) | 0.14  | (0.09) |
| **Control Variables**              |        |         |        |         |        |         |        |         |
| Female                             | 0.20  | (0.15) | 0.22  | (0.14) | 0.11  | (0.12) | 0.14  | (0.12) |
| Asian                              | 0.02  | (0.15) | -0.17 | (0.13) | -0.24*| (0.12) | -0.24*| (0.11) |
| Other Nationalities                | -0.23 | (0.18) | -0.24 | (0.16) | 0.01  | (0.14) | 0.04  | (0.14) |
| Electrical Engineering             | -0.04 | (0.12) | 0.01  | (0.10) | 0.02  | (0.09) | -0.01 | (0.09) |
| Dept. Other                        | 0.03  | (0.25) | -0.02 | (0.22) | 0.07  | (0.19) | 0.01  | (0.19) |
| Not Yet Tenure                    | -0.18 | (0.14) | -0.11 | (0.13) | -0.14 | (0.12) | -0.16 | (0.11) |
| Non-Tenure Track                  | -0.09 | (0.14) | -0.14 | (0.13) | -0.14 | (0.11) | -0.18 | (0.11) |
| Less than Half time Teaching       | 0.01  | (0.12) | 0.02  | (0.11) | 0.00  | (0.09) | 0.00  | (0.09) |
| **Theorized Effects**             |        |         |        |         |        |         |        |         |
| Characteristics of Innovation      |        |         |        |         |        |         |        |         |
| Relative Advantage (RA)            | 0.23***| (0.06) | 0.01  | (0.06) | 0.06  | (0.06) |        |         |
| Ease to Implement                  | 0.05  | (0.05) |        |         |        |         |        |         |
| Ease of Use (EU)                   | 0.23***| (0.06) | 0.07  | (0.05) | 0.06  | (0.05) |        |         |
| Adaptability                       | 0.08  | (0.05) |        |         |        |         |        |         |
| Readiness of Faculty Members' Toward Educational Innovations |        |         |        |         |        |         |        |         |
| Openness to Change                 | -0.03 | (0.07) |        |         |        |         |        |         |
| Discrepancy                        | 0.03  | (0.06) |        |         |        |         |        |         |
| Appropriateness of Change          | 0.11  | (0.09) |        |         |        |         |        |         |
| Efficacy of Faculty Members' Toward Change | 0.21**| (0.07) | 0.18* | (0.07) |        |         |        |         |
| Support from Principals to Change  | 0.03  | (0.05) |        |         |        |         |        |         |
| Valence                            | 0.20**| (0.07) | 0.15* | (0.07) |        |         |        |         |
| Attitude to Innovation             | 0.22**| (0.07) | 0.31***| (0.07) |        |         |        |         |
| Awareness of Innovation            | 0.05  | (0.03) |        |         |        |         |        |         |
| Care About Student Learning Outcomes | 0.11**| (0.04) | 0.11**| (0.04) |        |         |        |         |
| Motivation to be Innovative        | -0.03 | (0.04) |        |         |        |         |        |         |
| **Moderating Effects**             |        |         |        |         |        |         |        |         |
| RA x Efficacy of Faculty Members' Toward Change | 0.12  | (0.08) |        |         |        |         |        |         |
| RA x Valence                       | -0.01 | (0.08) |        |         |        |         |        |         |
| RA x Attitude to Innovation        | -0.14 | (0.09) |        |         |        |         |        |         |
| RA x Care About Student Learning Outcomes | -0.02 | (0.04) |        |         |        |         |        |         |
| EU x Efficacy of Faculty Members' Toward Change | -0.14**| (0.05) |        |         |        |         |        |         |
| EU x Valence                       | -0.16**| (0.06) |        |         |        |         |        |         |
| EU x Attitude to Innovation        | 0.23***| (0.06) |        |         |        |         |        |         |
| EU x Care about Student Learning Outcomes | -0.05 | (0.03) |        |         |        |         |        |         |
| Adjusted $R^2$                      | 0.90% | 20.20% | 40.70% | 45.30% |        |         |        |         |

**Notes:** N = 335. * = significant at 0.05 level. ** = significant at .01 level. *** = significant at .001 level. Standard errors are reported in parentheses.
In the fourth step of the analysis (Model 4), the significant direct effects found during the analysis in steps two and three were retained and eight two-way interactions between the characteristics of the innovation and faculty readiness variables were added. None of the faculty readiness variables moderated the relationship between relative advantage and intention to adopt. Several of the faculty readiness variables moderated the relationship between ease of use and intention to adopt. The significant moderating relationships include efficacy of faculty member towards change and ease of use ($b = -0.14$, $df = 312$, $p = .01$); valence and ease of use ($b= -0.16$, $df = 312$, $p=.004$); and attitude to the innovation and ease of use ($b = .23$, $df = 312$, $p < .001$).

![Diagram A](image1.png)

![Diagram B](image2.png)

![Diagram C](image3.png)

**Fig. 2.** Moderating effects on the relationship between ease of use and intention to adopt

We followed the procedure proposed by Aiken and West (1991) by plotting the interaction diagrams shown in Fig. 2. Low and high values of the variables are represented by the 25th and 75th percentile of the observed data. Fig. 2A, shows that the relationship between ease of use and intention to adopt depends on the efficacy of faculty members toward the change. By following the procedure proposed by Preacher, Curran, and Bauer (2006), the simple slope for low efficacy of faculty members toward change was significantly different from zero ($t_{(312)} = 2.41$, $p = 0.02$), while the slope of the
relationship between ease of use and intention to adopt for high efficacy was not statistically significant. This suggested that faculty members with a low level of confidence regarding change would have a greater intention to adopt educational innovations that are easier to use. In Fig. 2B, only the simple slope for low valence was significantly different from zero \( t_{(312)} = 2.64, p = .009 \), suggesting that faculty members who do not personally benefit from an innovation would have greater intention to adopt that innovation if it was easy to use. In Fig. 2C, only the simple slope for faculty members with high attitude to innovation was significantly different from zero \( t_{(312)} = 4.11, p < .001 \). This finding suggests that faculty members with a positive attitude toward an educational innovation would be more likely to adopt the innovation if it were easy to use.

5. Findings

This study shows that even though faculty members intend to adopt educational innovations, such as instructional materials, instructional strategies, enhancements to the curriculum, and/or means to enhance their expertise, there were several variables that influenced them in adopting these innovations. Since 59% of the innovations mentioned by the respondents are candidates for open access to learning, the results are applicable to this area of research.

First, although relative advantage and ease of use are significantly related to intention to adopt educational innovations, these characteristics of the innovations are no longer significant in the model that controls for faculty readiness variables. The relationship between ease of use and intention to adopt is moderated by several faculty readiness variables. This finding suggests that several readiness variables that might hinder a faculty member’s intention to adopt can be overcome by an easy-to-use innovation. Developers of educational innovations may need to focus on reducing the level of complexity in innovations (Borrego, Froyd, & Hall, 2010; Rogers, 2003) which will directly improve ease of use. As developers of innovations place a greater emphasis on creating innovations that are easy to use, this will also improve faculty members’ perceived relative advantage (Compeau, Meister, & Higgins, 2007), which should therefore improve the intention to adopt the educational innovations. Previous research by Cheville and Bunting (2011) found ease of use can depend on faculty members’ level of expertise and knowledge of the educational innovation being investigated. This variable might be even more important to facilitate next-generation learning. For example, Zhang and Liao (2015) analyzed educational Apps and point out that educational Apps for formal education are limited in quantity; lack quality; are not easy-to-use; and don’t have a clear business model for sustainability.

Second, the attitude of faculty members toward innovations has both a significant direct relationship to intention to adopt and moderates the relationship between ease of use and intention to adopt. Borrego, Froyd, and Hall (2010) found faculty members’ attitudes toward innovations are an important part of peers’ willingness to adopt new pedagogies. Moreover, Qualters, Sheahan, Mason, Navick, and Dixon (2008) found the amount of effort needed by faculty members to reconfigure their classes was part of the attitude that faculty members develop toward new educational innovations. Prior research has suggested poor attitudes to innovations are often the result of a lack of time, training, motivation, and technological naïveté (Bernold, 2008; Christie & Jurado, 2009; Kantardjieff, 2010; Veldman, De Wet, Ike Mokhele, & Bouwer, 2008). This variable is equally important for the Open Access to learning and education to become more
prevalent and it is critical that developers include strategies to increase the attitude of the faculty toward the innovations.

Third, this study empirically supports that faculty members who care about student learning outcomes have a higher intention to adopt educational innovations. Bourrie, Cegielski, Jones-Farmer, and Sankar (2014b) found faculty members who care about student learning outcomes focused on learning rather than focused on grades. This is also stressed by Barrett et al. (2009) when they discuss the challenges in adopting OpenCourseWare at the United Nations University. This may suggest that OpenCourseWare may be more readily adopted in campuses where a strong emphasis is placed on student learning.

Finally, the results show that in order for open access to learning to be adopted more widely, funding needs to be directed to building researcher capacity modeled on the US land grant university agricultural extension service that embeds agents in communities to bring research and practice through matched federal and state funds (Cavanaugh, Sessums, & Drexler, 2015). Developing easy-to-use educational innovations is an expensive and time-consuming activity requiring collaboration between academicians and industry. Our research shows that positive attitude of faculty and administration is critical in achieving effective dissemination. Past research reveals that traditional research universities tend not to reward explorative research that improve the pedagogy and education of STEM technologies (Holmstrom, Ketokivi, & Hameri, 2009). At the same time, Gates Foundation recently announced to their grant recipients that all publications shall be available immediately upon their publication, without any embargo period, thereby encouraging open access to the knowledge created as a result of their grants (Straumsheim, 2014). Therefore, we believe that a new method of identifying, building, and funding “open access grant” universities that develop easy-to-use educational innovations, make them available on an open access platform, and spread them widely by embedding agents in community colleges, schools, and other educational institutions is essential. Without such a bold initiative, the current low level of adoption of MOOCs and other open access materials may persist (Keppell, Suddaby, & Hard, 2015).

6. Limitations and future research

In this study, we studied educational innovations of curriculum development, development of faculty expertise, instructional materials, and instructional strategies. Even though all these innovations are available to faculty members in different institutions, in the future, it is possible to limit the survey to clearly identified Open Access to Learning and Education Innovations. Data were collected from faculty members at ABET accredited institutions that were part of an electrical engineering or computer science departments. Future research should also look to validate or extend our model using other colleges (Tornatzky et al., 1983). Such investigations may use the methodology outlined in this paper to find similarities and/or differences that may exist between departments. Data were self-reported and cross-sectional. Since the intent to adopt educational innovations unfolds over time, future research could validate this model using longitudinal data.
7. Conclusions

This study used a survey methodology to obtain the insights of electrical engineering and computer science faculty members at ABET certified programs in the United States. The responses from the faculty members included the use of many educational innovations (such as online learning systems, intelligent tutors, collaborative training tools, learning with mobile devices, educational games, simulation systems, web services, and authoring tools) that could be available as Open Access CourseWare and available to a worldwide audience. The results suggest that ease of use and care about student learning outcomes directly influence intention to adopt educational innovations. Additionally, faculty members’ attitude toward the innovation, efficacy toward change, and valence each moderated the relationship between ease of use and intention to adopt educational innovations. We conclude that OpenCourseWare developers need to ensure that ease of use is emphasized in the CourseWare and they need to propagate these initially in institutions where faculty members have positive attitude to the CourseWare and care about student learning. In addition, new strategies to provide grants to institutions that develop easy-to-use learning technologies and disseminate them using embedded agents in educational institutions may be needed. Such an initiative might lead to wider adoption of MOOCS and other access materials in the future.

Acknowledgements

This work was supported by the Division of Undergraduate Education at the National Science Foundation under grant #1140542. Any opinions, findings, and conclusions or recommendations expressed in this article are those of the authors and do not necessarily reflect the view of the National Science Foundation.

References

Agarwal, R., & Prasad, J. (1999). Are individual differences germane to the acceptance of new information technologies? Decision Sciences, 30(2), 361–391.
Aiken, L. S., & West, S. G. (1991). Multiple regression: Testing and interpreting interactions. Thousand Oaks, CA: Sage.
Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211.
Alpkan, L., Bulut, C., Gunday, G., Ulusoy, G., & Kilic, K. (2010). Organizational support for intrapreneurship and its interaction with human capital to enhance innovative performance. Management Decision, 48(5), 732–755.
Armenakis, A. A., Bernerth, J. B., Pitts, J. P., & Walker, H. J. (2007). Organizational change recipients’ beliefs scale: Development of an assessment instrument. The Journal of Applied Behavioral Science, 43(4), 481–505.
Armenakis, A. A., Harris, S. G., & Feild, H. S. (1999). Making change permanent: A model for institutionalizing change interventions. In W. Pasmore & R. Woodman (Eds.), Research in organizational change and development (Vol. 12, pp. 97–128). Stamford, CT: JAI Press.
Armenakis, A. A., Harris, S. G., & Mossholder, K. W. (1993). Creating readiness for organizational change. Human relations, 46(6), 681–703.
Barrett, B. F. D., Grover, V. I., Janowski, T., van Lavieren, H., Ojo, A., & Schmidt, P. (2009). Challenges in the adoption and use of OpenCourseWare: Experience of the
United Nations University. *Open Learning*, 24(1), 31–38.

Bartlem, C. S., & Locke, E. A. (1981). The Coch and French study: A critique and reinterpretation. *Human relations*, 34(7), 555–566.

Bernold, L. E. (2008). Applying total-quality-management principles to improving engineering education. *Journal of Professional Issues in Engineering Education and Practice*, 134(1), 33–40.

Borrego, M., Froyd, J. E., & Hall, T. S. (2010). Diffusion of engineering education innovations: A survey of awareness and adoption rates in U.S. engineering departments. *Journal of Engineering Education*, 99(3), 185–207.

Bourrie, D. M., Cegielski, C. G., Jones-Farmer, L. A., & Sankar, C. S. (2014a). Identifying characteristics of dissemination success using an expert panel. *Decision Sciences Journal of Innovative Education*, 12(4), 357–380.

Bourrie, D. M., Cegielski, C. G., Jones-Farmer, L. A., & Sankar, C. S. (2014b). *What makes educational innovations stick? A Delphi Approach*. Paper presented at the ASEE Southeastern Section Conference, Macon, GA.

Bourrie, D. M., Sankar, C. S., & Jones-Farmer, L. A. (2015). Conceptualizing interactions between innovation characteristics and organizational members' readiness to adopt educational innovations. *International Journal of Engineering Education*, 31(4), 967–985.

Cavanaugh, C., Sessums, C., & Drexler, W. (2015). A call to action for research in digital learning: Learning without limits of time, place, path, pace... or evidence. *Journal of Online Learning Research*, 1(1), 9–15.

Cheville, A., & Bunting, C. (2011). Engineering students for the 21st century: Student development through the curriculum. *Advances in Engineering Education*, 2(4), 1–37.

Christie, M., & Jurado, R. G. (2009). Barriers to innovation in online pedagogy. *European Journal of Engineering Education*, 34(3), 273–279.

Clarke, J. S., Ellett, C. D., Bateman, J. M., & Rugutt, J. K. (1996). *Faculty receptivity/resistance to change, personal and organizational efficacy, decision deprivation and effectiveness in research 1 universities*. Paper presented at the Annual meeting of the Association for the Study of Higher Education, Memphis, TN.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, N.J.: Lawrence Erlbaum Associates, Inc.

Compeau, D. R., Meister, D. B., & Higgins, C. A. (2007). From prediction to explanation: Reconceptualizing and extending the perceived characteristics of innovating. *Journal of the Association for Information Systems*, 8(8), 409–439.

Dancy, M., & Henderson, C. (2010). Pedagogical practices and instructional change in physics faculty. *American Journal of Physics*, 78(10), 1056–1063.

Di Benedetto, C. A., Calantone, R. J., & Zhang, C. (2003). International technology transfer: Model and exploratory study in the People's Republic of China. *International Marketing Review*, 20(4), 446–462.

Fairweather, J. (2008). *Linking evidence and promising practices in science, technology, engineering, and mathematics (STEM) undergraduate education*. Washington, DC: The National Academies National Research Council Board of Science Education.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Froyd, J. E., Borrego, M., Cutler, S., Henderson, C., & Prince, M. J. (2013). Estimates of use of research-based instructional strategies in core electrical or computer engineering courses. *IEEE Transactions on Education*, 56(4), 393–399.

Gillard, S., Nolan, E., & Bailey, D. (2008). Ten reasons for IT educators to be early adopters of IT innovations. *Journal of Information Technology Education*, 7, 21–33.

Guilabert, M. B. (2005). *Attitudes toward consumer-customized high-tech products: The...
role of perceived usefulness, perceived ease of use, technology readiness, and customer customization sensitivity. Doctor of Philosophy dissertation, Georgia State University.

Hall, G. E., George, A. A., & Rutherford, W. L. (1979). Measuring stages of concern about the innovation: A manual for use of the SoC Questionaire (Report No. 3032). Austin, TX: Southwest Educational Development Laboratory.

Hall, G. E., & Hord, S. M. (2006). Implementing change: Patterns, principles, and potholes. Boston, MA: Pearson/Allyn & Bacon.

Hardgrave, B. C., Davis, F. D., & Riemenschneider, C. K. (2003). Investigating determinants of software developers’ intentions to follow methodologies. *Journal of Management Information Systems, 20*(1), 123–151.

Hall, G. E., & Hord, S. M. (2006). Implementing change: Patterns, principles, and potholes. Boston, MA: Pearson/Allyn & Bacon.

Hardgrave, B. C., Davis, F. D., & Riemenschneider, C. K. (2003). Investigating determinants of software developers' intentions to follow methodologies. *Journal of Management Information Systems, 20*(1), 123–151.

Hazen, B. T., Wu, Y., & Sankar, C. S. (2012). Factors that influence dissemination in engineering education. *IEEE Transactions on Education, 55*(3), 384–393.

Hazen, B. T., Wu, Y., Sankar, C. S., & Jones-Farmer, L. A. (2012). A proposed framework for educational innovation dissemination. *Journal of Educational Technology Systems, 40*(3), 301–321.

Henderson, C., Dancy, M. H., & Niewiadomska-Bugaj, M. (2012). Use of research-based instructional strategies in introductory physics: Where do faculty leave the innovation-decision process? *Physical Review Special Topics - Physics Education Research, 8*, 020104.

Heywood, J. (2006). Factors in the adoption of change: Identity, plausibility and power in promoting educational change. In *Proceedings of 36th Annual IEEE Frontiers in Education*.

Holt, D. T., Armenakis, A. A., Feild, H. S., & Harris, S. G. (2007). Readiness for organizational change: The systematic development of a scale. *The Journal of Applied Behavioral Science, 43*(2), 232–255.

Kantardjieff, K. (2010). Pushing the boundaries of technology to educate and train the next generation of crystallographers. *Journal of Applied Crystallography, 43*, 1276–1282.

Karahanna, E., Agarwal, R., & Angst, C. M. (2006). Reconceptualizing compatibility beliefs in technology acceptance research. *MIS Quarterly, 30*(4), 781–804.

Keppell, M., Suddaby, G., & Hard, N. (2015). Assuring best practice in technology-enhanced learning environments. *Research in Learning Technology, 23*: 25728.

Loftus, M. (2013). A schools of one's own. *ASEE Prism, 22*, 45–47.

Macdonald, R. H., Manduca, C. A., Mogk, D. W., & Tewksbury, B. J. (2005). Teaching methods in undergraduate geoscience courses: Results of the 2004 On the cutting edge survey of U. S. faculty. *Journal of Geoscience Education, 53*(3), 237–252.

Miller, B. K., & Chiodo, B. (2008). *Academic entitlement: Adapting the equity preference questionnaire for a university setting*. Paper presented at the Southern Management Association, , St. Pete Beach, FL.

Miller, V. D., Johnson, J. R., & Grau, J. (1994). Antecedents to willingness to participate in a planned organizational change. *Journal of Applied Communication Research, 22*(1), 59–80.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192–222.

National Science Foundation (NSF). (2015). *Improving undergraduate STEM education*. Retrieved from http://www.nsf.gov/pubs/2014/nsf14588/nkf14588.htm

Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational tools for probing...
interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics, 31*, 437–448.

Qualters, D. M., Sheahan, T. C., Mason, E., Navick, D. S., & Dixon, M. (2008). Improving learning in first-year engineering courses through interdisciplinary collaborative assessment. *Journal of Engineering Education, 97*(1), 37–45.

Richardson, H. A., Simmering, M. J., & Sturman, M. C. (2009). A tale of three perspectives: Examining post hoc statistical techniques for detection and correction of common method variance. *Organizational Research Methods, 12*(4), 762–800.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press/Simon & Schuster.

Schwab, K., & Sala-i-Martin, X. (2013). *The global competitiveness report 2013-2014: Full data edition*. Retrieved from [http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf](http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf)

Singer, S. R., Nielsen, N. R., & Schweingruber, H. A. (2012). *Discipline-based education research: Understanding and improving learning in undergraduate science and engineering*. Washington, D. C.: National Academies Press.

Straumsheim, C. (2014). *Gates goes open*. Inside Higher Ed. Retrieved from [https://www.insidehighered.com/news/2014/11/24/gates-foundation-announces-open-access-policy-all-grant-recipients](https://www.insidehighered.com/news/2014/11/24/gates-foundation-announces-open-access-policy-all-grant-recipients)

Taylor, S., & Todd, P. (1995). Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *International Journal of Research in Marketing, 12*(2), 137–155.

Teo, H.-H., Wei, K.-K., & Benbasat, I. (2003). Predicting intention to adopt interorganizational linkages: An institutional perspective. *MIS Quarterly, 27*(1), 19–49.

Tornatzky, L. G., Eveland, J. D., Boylan, M. G., Hetzner, W. A., Johnson, E. C., Roitman, D., & Schnedier, J. (1983). *The process of technological innovation: Reviewing the literature*. National Science Foundation. Productivity Improvement Research Section. Washington, D. C.: National Science Foundation.

Veldman, F. J., De Wet, M. A., Ike Mokhele, N. E., & Bouwer, W. A. J. (2008). Can engineering education in South Africa afford to avoid problem-based learning as a didactic approach? *European Journal of Engineering Education, 33*(5/6), 551–559.

Walczyk, J. J., Ramsey, L. L., & Zha, P. (2007). Obstacles to instructional innovation according to college science and mathematics faculty. *Journal of Research in Science Teaching, 44*(1), 85–106.

Waugh, R. F. (2000). Towards a model of teacher receptivity to planned system-wide educational change in a centrally controlled system. *Journal of Educational Administration, 38*(4), 350–367.

Waugh, R., & Godfrey, J. (1993). Teacher receptivity to system-wide change in the implementation change. *British Educational Research Journal, 19*(5), 565–578.

Zhang, J., & Liao, B. (2015). Learning on the fingertips: The opportunities and challenges of educational apps. *Journal of Education and Practice, 6*(20), 62–67.