Knowledge Management & E-Learning
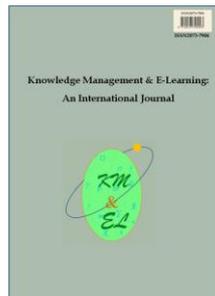
Growing the intention to adopt educational innovations: An empirical study

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Abstract: In order for the Open Access (OA) to learning concept to a have 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.

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conducts research on information technology capabilities, innovation diffusion and dissemination, health information systems, and how information technology can improve decision making and performance.

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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).
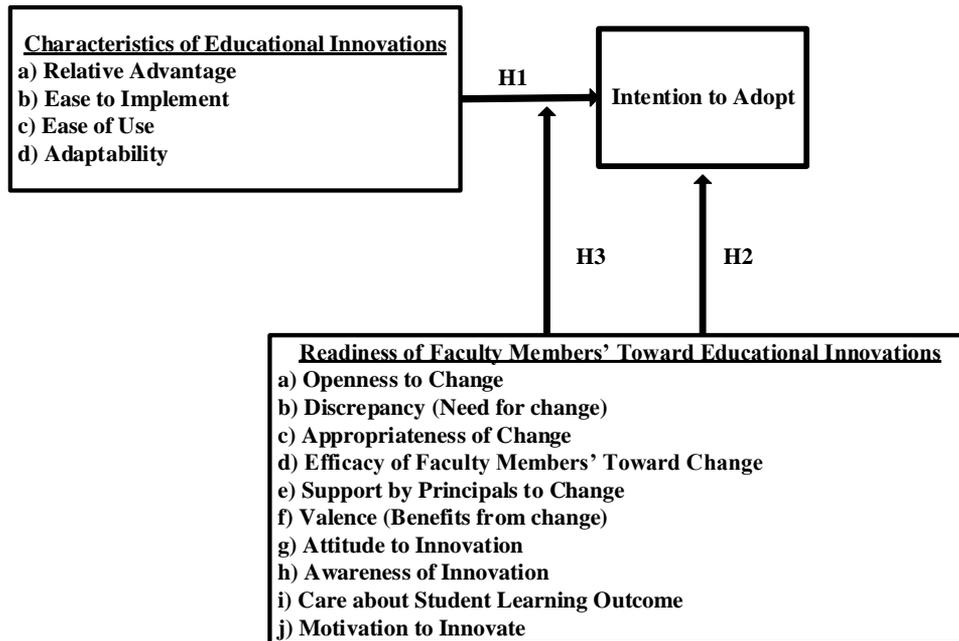

Fig. 1. The research model

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

- 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	0.92															
2. Ease of implement	.75	4.09	1.35	.22**														
3. Ease of use	.91	5.08	1.18	.48**	.55**													
4. Adaptability	.90	5.08	1.10	.14*	.11*	.26**												
5. Openness to change	.91	5.62	0.87	.35**	.09	.33**	.18**											
6. Discrepancy	.86	5.48	0.99	.25**	-.04	.17**	.19**	.60**										
7. Appropriateness of change	.87	5.96	0.77	.46**	.22**	.41**	.35**	.35**	.37**									
8. Efficacy of faculty members' toward change	.87	5.66	0.91	.48**	.45**	.66**	.20**	.36**	.25**	.54**								
9. Support of principal to change	.87	4.78	1.15	.10	.11*	.26**	.22**	.27**	.14*	.18**	.21**							
10. Valence	.74	5.60	0.93	.46**	.17**	.35**	.28**	.38**	.36**	.66**	.53**	.19**						
11. Attitude to innovation	.91	5.75	0.99	.45**	.26**	.48**	.31**	.40**	.35**	.68**	.62**	.20**	.72**					
12. Awareness of Innovation	.86	4.10	1.35	.17**	.10	19**	.04	.01	.01	.00	.09	.20**	.00	.01				
13. Care about student learning outcomes	.81	4.99	1.20	.02	-.16**	-.06	.15**	.16**	.18**	.01	-.08	.07	.10	.08	.03			
14. Motivation to innovative	.85	3.92	1.34	.17**	.04	.20**	.14*	.15**	.08	.05	.12*	.53**	.12*	17**	.16**	.08		
15. Intention to adopt	.88	6.06	1.00	.36**	.27**	.41**	.19**	.28**	.27**	.50**	.53**	.17**	.54**	.58**	.10	.15**	.08	
16. Attitude toward color green	.72	3.72	1.06	-.02	-.05	-.04	-.06	-.03	-.04	-.02	-.05	-.01	-.03	-.03	-.08	.10	-.05	.02

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 b	Model 1 se	Model 2 b	Model 2 se	Model 3 b	Model 3 se	Model 4 b	Model 4 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 = -.14, df = 312, p = .01); valence and ease of use (b= -.16, df = 312, p=.004); and attitude to the innovation and ease of use (b = .23, df = 312, p < .001).
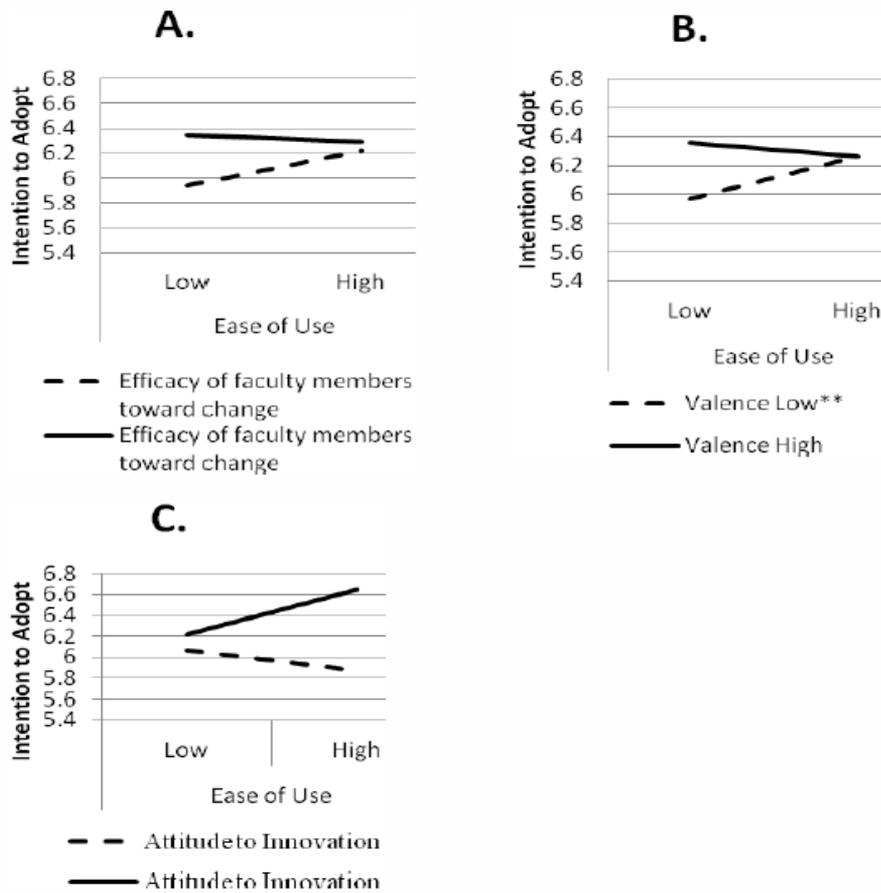
Note: y-axis is the mean intention to adopt score based on a seven-point Likert scale.
* = significant at 0.05 level; ** = significant at .01 level; *** = significant at .001 level.

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.

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