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Predicting the Probability for Faculty Adopting an Audience Response System in Higher Education

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Abstract

Instructional technologies can be effective tools to foster student engagement, but university faculty may be reluctant to integrate innovative and evidence-based modern learning technologies into instruction. Based on Rogers' diffusion of innovation theory, this quantitative, nonexperimental, one-shot cross-sectional survey determined what attributes of innovation (relative advantage, compatibility, complexity, trialability, and observability) predict the probability of faculty adopting the audience response system (ARS) into instruction. The sample of the study consisted of 201 faculty at a university in the southeastern United States. Binary logistic regression analysis was used to determine the attributes of innovation that predict the probability of faculty adopting the ARS into instruction. Out of the five attributes, compatibility and trialability made significant contributions to the model. The implication of the findings is that, in order to maximize adoption, the faculty needs to be given the opportunity to pre-test the ARS prior to implementation, and they need to know how the technology will assist them in achieving their pedagogical goals. Recommendations were made to leverage these attributes to foster faculty adoption of the ARS into instruction.

Keywords: clicker, audience response system, instructional technology adoption

Introduction

The advancement of technology and telecommunication shapes every aspect of modern life including the way individuals socialize, play, work, and learn. Students are inundated with digital technologies, such as computers, tablets, video games, digital media players, smartphones, and other gadgets of the digital age (Frand, 2006). It is not surprising that students are eager to incorporate technologies to enhance their educational experience (Van De Werf & Sabatier, 2009). Researchers suggested that current and future students envision roles of emerging technologies in education differently than previous generations (Prensky, 2001; Project Tomorrow, 2011). New generations of students anticipate emerging instructional technologies to help create a new learning environment to engage them in contextually based contents (Frand, 2006; Project Tomorrow, 2014). On the contrary, the ed-

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ucational innovations that faculty have accepted and consistently employed are primarily limited to PowerPoint slideshows and course management systems adopted by their institutions (Davidson & Goldberg, 2010). In fact, it is well-documented that educators do not make effective use of instructional technologies (Bauer & Kenton, 2005; Bingimals, 2009; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, Sendurur, 2012; Gautreau, 2011; Hixon & Buckemeyer, 2009; Keengwe & Kang, 2012; Levin & Wadmany, 2008; Nichols, 2008; Schneckenberg, 2009). Bingimals (2009) conducted a meta-analysis of the literature on the perceived barriers to technology adoption, particularly in science education. The findings revealed various inter-related factors, from the teachers' lack of competencies in problem-solving technical issues to their failure of leveraging the strengths of instructional technologies (Bingimals, 2009). However, Bingimals (2009) was unable to sort out the complex relationships among the identified barriers because of their interdependent nature.

Based on current evidence, instructional technology can be an efficient tool to foster student learning (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Lai, Khaddage, & Knezek, 2013). However, it cannot be effective if educators are not using technologies conscientiously and judiciously as an integral part of an instructional delivery system to facilitate teaching and learning (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Tamim et al. (2011) conducted a second-order meta-analysis that revealed significant positive effects with small to moderate effect size on students' achievement favoring the utilization of instructional technologies. These included, but were not limited to, computer assisted instruction, computer-based instruction, and digital media over instructions that were more traditional. Based on the positive evidence in the literature and encouraged through national accreditation standard on technology use (Southern Association of Colleges and Schools [SACS], 2012), universities have begun to invest in various instructional technologies. However, the decision to adopt any technology into coursework usually rests with the faculty who are teaching the courses (Ertmer et al., 2012). This unintentional approach to the integration of instructional technologies may have contributed to the inconsistencies in adoption. Researchers have suggested that this problem exists in educational settings throughout the United States (Bauer & Kenton, 2005; Keengwe, Onchwari, & Wachira, 2008; Schneckenberg, 2009). In order to target the supports, training, and resources necessary for successful adoption of instructional technology, it is important to identify the factors influencing faculty adoption of instructional technology in the teaching and learning process (Bingimals, 2009). Therefore, the purpose of the study was to determine what attributes of innovation (relative advantage, compatibility, complexity, trialability, and observability) predict the probability of faculty adopting the Audience Response System (ARS) into instruction.

Innovation Diffusion Model

The present study applied Rogers's (2003) innovation diffusion model to a specific instructional technology, the ARS. The model for diffusion of innovation developed by Rogers in 1962 is a well-studied framework, which has since formed the basis of many studies in the field of instructional technology (Rogers, 2003). Concisely, the diffusion of innovations is a theory that explains how, why, and at what rate new ideas and technology spread through societies. The perception of innovations by potential adopters forms the cornerstone of Rogers's (2003) diffusion theory. He describes the characteristics of innovation in terms of its perceived attributes, which are relative advantage, compatibility, complexity, trialability, and observability. According to Rogers (2003), the differences in the perception of these attributes by the individuals contribute to the different rates of adoption among individuals. Therefore, it is important to understand the effects of attributes on any innovations as they influence the adoption decisions of the potential adopters. Relative advantage represents the degree to which an adopter perceives an innovation as being better than its precursor. Compatibility represents the degree to which an adopter perceives an innovation as being consistent with the existing values, needs, and experiences of potential adopters. Complexity represents the degree to which an adopter perceives an innovation as being difficult to use. Observability represents the degree to which the effects of using an innovation are visible to others. Finally, trialability is the attribute that represents the degree to which an innovation might be experimented with before adoption (Rogers, 2003).

According to Rogers (1995), "the perceived attributes of an innovation are one important explanation of the rate of adoption of an innovation" (p. 206). He theorizes that individuals or a social unit will adopt an innovation if they perceive it to have particular attributes. Specifically, innovations that potential adopters perceive to have more relative advantage, compatibility, trialability, observability, and less complexity are likely to be adopted more rapidly (Rogers, 2003). Among these five attributes, relative advantage, compatibility, and complexity seem to be the most influential in affecting decision making by adopting individuals (Huang, 2012; Rogers, 1995, 2003; Sultan & Chan, 2000).

Audience Response System (ARS)

An Audience Response System is a combination of computer software and hardware designed to present questions, record responses, and to provide feedback to the audiences. The hardware aspect of the system consists of a radio receiver that plugs into the presenter's computer and the audience's remote clickers. The software aspect of the system consists of the driver for the receiver and the software add-in that enhances functions to the PowerPoint software on the presenter's computer. The add-in allows the presenter to create questions and receive data from the audience's clickers using Microsoft PowerPoint, which is widely used and technically supported in academic settings. Instead of the radio receiver and remote clickers, the latest ARS is internet-based and works with the students' smartphones, laptops, and tablets. The question types used with the ARS may include multiple choice, true or false, numeric, ordering, and even short answer depending on the capabilities of specific ARSs. The instructor displays the questions on the projection screen using the PowerPoint software, and the audiences respond by entering their answers using the remote clickers. The ARS appears in the literature under different names, some examples of which are classroom response system (CRS), student response system (SRS), clicker, and classroom polling system. These commercially available systems are remarkably similar in function (Kay & LeSage, 2009). The technology behind ARS is easy to navigate and requires only an intermediate level of computer skills, which allows the educator to focus on pedagogy, rather than on the technology itself (Efstathiou & Bailey, 2012).

Research has demonstrated that ARSs can be a promising pedagogical tool in the classrooms. There was substantial evidence to suggest that higher education students were very positive toward the use of ARSs (Fies & Marshall, 2006; Guse & Zobitz, 2011; Heaslip, Donovan, & Cullen, 2014; Laxman, 2011; Oigara & Keengwe, 2013; Simpson & Oliver, 2007; Vaterlans, Beckert, Fauth, & Teemant, 2012). Students reported that they were more interested, engaged, and attentive when an ARS was used during lectures (Preszler, Dawe, Shuster, & Shuster, 2007; Simpson & Oliver, 2007). Students also reported that the use of ARSs encouraged class engagement and student–faculty exchange, reinforced key concepts, challenged metacognition, and validated student comprehension, as the discussion of answer choices was beneficial to support learning (Laxman, 2011; Lee & Dapremont, 2012; Revell & McCurry, 2010; Russell, McWilliams, Chasen, & Farley, 2011). According to current studies, one of the key benefits of using an ARS was the ability to obtain accurate real-time assessment of class understanding, and instruction could be modified contingent upon student assessment gathered at strategic points within a lecture (Efstathiou & Bailey, 2012; Heaslip, 2014). If the majority of students failed to grasp the concept, an experienced instructor could offer alternative explanations of the concept in question (Caldwell, 2007; Draper & Brown, 2004).

In addition to the aforementioned benefits, a number of researchers discovered that when instructors employed ARS to facilitate the pedagogical strategy of peer instruction, the quantity and quality of class discussions improved (Brewer, 2004; Draper & Brown, 2004). Peer instruction could be used in conjunction with an ARS when an instructor presents a question using the ARS, and then collects and shares student responses with the class without providing the correct answer. Subsequently, the class would be instructed to discuss possible solutions based on the student responses provided by the ARS. After the initial class discussion, the instructor could present the refined solutions to the class to stimulate further discussions (Brewer, 2004; Draper & Brown, 2004). In essence, using an ARS could potentially change a static, one-way transmission of information into a dynamic and student-centered learning experience (Martyn, 2007). The literature emphasized that the implementation of appropriate pedagogical strategies in combination with the use of ARS could ultimately influence student success by encouraging active participation and improving attentiveness and retention (Kay & LeSage, 2009; Simpson & Oliver, 2007; Vaterlans et al., 2012).

Method

Research Design and Approach

This research was a quantitative, nonexperimental, one-shot cross-sectional study in which participants provided survey data at one point in time regarding their perception of the theoretical attributes of innovation, and linked these to their propensity of adopting ARS into instruction. A predictive design was implemented to determine the attributes of innovation that would predict faculty adopting ARS into instruction.

Setting and Sample

The research site for this study was a nonprofit, private university located in the southeastern United States, which employed approximately 600 full and part-time faculty members. The statistical analysis method, logistic regression, was used to establish the requirements for the sample size. The formula applied to determine sample size was $N = 10\ k/p$, where k is the number of independent variables, p is the smallest of the proportions of negative or positive cases in the population, and N is the minimum number of cases to include in the study (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996).

In this study, there were five predictor or independent variables to include in the model, and the proportion of positive cases was estimated to be 0.25, or 25%. According to the formula above, the minimum number of cases required was 200. Based on approximately 600 full and part-time faculty with a 30% to 40% response rate (Lodico, Spaulding, & Voegtle, 2010), 180 to 240 cases were needed for analysis. Therefore, this study included all 600 accessible faculty who met the inclusion criteria. Study participants were full-time, part-time, or adjunct faculty members, who had active teaching appointments at the university. The faculty administrators who did not have active teaching appointments and faculty members who taught online were excluded from the study. Participation in this project was strictly voluntary.

Instrumentation and Materials

The research instrument for the study was adapted and modified from an instrument developed by Moore and Benbasat (1991), which measured the perceptions of office workers adopting an information technology innovation based on the attributes of innovation developed by Rogers (2003). The instrument had good construct and content validity as well as reliability. The average value of the reliability coefficient for the five attributes was 0.83. The Kappa scores were also correspondingly high, with an average 0.82, which indicated good inter-rater reliability (Moore & Benbasat, 1991).

Minor modifications were made to the Moore and Benbasat instrument to reflect the purpose of this study, which was to test the attributes of innovation in the context of adopting ARS into instruction in higher education. Moore and Benbasat (1991) expanded upon Rogers's (2003) original five attributes of innovations to include two additional untested attributes: voluntariness and image. These two attributes were out of the scope of the current study; therefore, the associated questions were removed. Moore and Benbasat, (1991) did not define the term adoption; therefore, the term, adoption, was defined based on Rogers's (2003) diffusion of innovations model. For the purpose of this study, an adopter is a faculty member who has made the decision to make use of ARS in his or her teaching when the use of it is deemed appropriate; therefore, an adopter was not necessarily a current user of the technology.

The first part of the revised instrument consisted of ten demographic questions, which collected data on the relevant characteristics of the population in the context of a higher education setting. The second part sought information regarding faculty's perceived attributes of the innovation and their adoption of the ARS. The faculty's perception of the attributes of innovations (relative advantage, compatibility, complexity, observability, and trialability) were measured on a seven-point Likert scale ranging from 1-strongly disagree to 7-strongly agree. The instrument was pilot-tested to verify its face and content validity. Five faculty members from the Department of Mathematics and Computer Science were selected based on their expertise in the context of instructional technology. The purpose of the pilot study was to provide information concerning errors, ambiguities, and clarity of the survey questions, and to identify any issue of content validity.

Data Collection

The data collection process began after the approval from the Institutional Review Board (IRB). The survey was disseminated by email to all faculty in the research site. The email consisted of the cover letter, instructions, and weblink to the survey instrument. The participants gave their consents by completing and submitting the web-based survey. The survey instrument was hosted using SurveyMonkey (www.surveymonkey.com) for its flexibility, convenience, and accessibility. In order to protect participant privacy and confidentiality, the researcher did not ask or record the participants' identifications. The sensitive demographic information, such as age and years taught in the current department, was collected using categorical scales to decrease the likelihood that participants be easily identified by the demographic data. A follow-up email reminder was sent to all participants after two weeks. The same procedure was repeated twice until 200 participants completed the survey.

Results

Prior to data analysis, the negatively keyed items on the instrument were reversed scored because reverse-scoring the negatively-keyed items ensured that all of the items in the survey were consistent with each other in terms of the levels of agreement the scores implied. The validity and reliability of the instrument were reexamined because of the minor modifications made to the original instrument.

Although the results of the pilot study had confirmed the content validity of the instrument, it was beneficial to assess the degree to which the data met the expected structure as discussed by Moore and Benbasat (1991). The dimension reduction function in SPSS was used to conduct an exploratory factor analysis on the data. The results of the analysis revealed that the items generally loaded on the correct factors. According to Moore and Benbasat (1991), relative advantage and compatibility did not emerge as separate factors in their original instrument. Although conceptually different, these two attributes might have a causal relationship to each other. For example, it would be unlikely that the respondents perceived the advantages of using certain innovation if its use were perceived as incompatible with their experiences. Therefore, four factors, instead of five, were used in the analysis. The exploratory factor analysis using principal axis component extraction with the Promax rotation revealed that all but three items loaded on their corresponding factors. The three problematic items were removed from further analysis. After dropping the three items, the factor analysis was recalculated to confirm correct loading of the factors. The Barlett test of sphericity for the attributes was significant ($p < 0.000$) and the Kaiser-Olkin measure of sample adequacy (KMO) for the attributes was adequate (KMO = 0.927). These tests met the standards for the appropriateness of factor analysis. The variance explained for the factors was 77.08%. Factor loading of the attributes was well above acceptable value of 0.4 (Stevens, 1992). These results of the factor analysis were similar to the research framework shown in the study reported by Moore and Benbasat (1991). Thus, the instrument retained its construct validity despite the minor modifications. Cronbach's alpha values were calculated for each of the attribute, which confirmed that the instrument exhibited good reliability. All alpha values were more than 0.8, which indicated high internal consistency among the items listed under each attribute thereby indicating acceptable levels of reliability.

Demographics of the Sample

The demographic data, which are categorical in nature, were analyzed using descriptive statistics. Demographic information was used to confirm participants met the inclusion criteria for the research study and to summarize the participants overall characteristics. Out of the 204 faculty members, who participated in the study, three did not meet the inclusion criteria; therefore, they were excluded from the study. The data provided by the remaining 201 faculty were included in the analysis. The response rate was 34%, which was similar to what was expected in internal surveys (Lodico et al., 2010). The minimum number of cases required for conducting binary logistic analysis on the five predictor variables was met.

Of the 201 respondents, 118 (58.7%) were female. The majority of respondents were between 45 and 64 years old. Actually, 60 (29.9%) of them were between 45 and 54 years old, and 67 (33.3%) of them were between 55 and 64 years old. As for employment status, 178 (88.6%) of the respondents were full-time educators. More than three-quarter (79.1%) of the respondents ($n = 159$) held a doctoral degree. One hundred and seventy-eight (88.6%) respondents were full-time faculty. The majority of faculty in the study held either the academic rank of assistant professor (44.8%) or associate professor (28.9%). Twenty-nine (14%) of the 201 respondents held the rank of instructor while twenty-four (11.9%) held the rank of full professor. About half (52.2%) of the 201 respondents had more than ten years of experience teaching at the university level ($n = 105$), spanning from 10 to 40 years.

In the demographic profile section of the survey, two questions concerning the adoption of instructional technology were asked: (a) At this time, do you consider yourself an adopter of the ARS? (b) Which of the following statements best describes your disposition toward the adoption of change? The data showed that 37 (18.4%) of the 201 respondents considered themselves an adopter of the ARS. Out of the 37 respondents, who considered themselves adopters of the ARS, 24 of them were female (64.9%) and 13 of them were male (35.1%). Similarly, out of the 164 respondents who considered themselves non-adopter of the ARS, 94 of them were female (57.3%), and 70 of them were male (42.7%). A Chi-square test of independence using the cross-tab function was conducted in SPSS to examine the relation between gender and the adoption of ARS. The result was insignificant, (X^2 (1) = 0.79, $p > .05$).

Measurement of Attributes of Innovation

The mean scores of the predictor variables of relative advantage, compatibility, complexity, trialability, and observability were analyzed using logistic regression in an attempt to answer the research question: What attributes of innovation (relative advantage, compatibility, complexity, trialability, and observability) predict the probability of faculty adopting ARS into instruction?

The basic purpose of binary logistic regression is to explore the influence of multiple independent variables on a binary outcome of interest. Similar to other inferential statistics, binary logistic regression has a few assumptions that must be met to produce reliable results (Long, 1997). In a Logistic Regression model, there is an assumption on the degree of collinearity among predictor variables. The term collinearity implies that two variables are near perfect linear combinations of one another. When more than two variables are involved, it is often called multicollinearity, although the two terms are often used interchangeably (Dormann et al., 2013). Multicollinearity is the undesirable situation when the correlations among the independent variables are strong. In other words, when predictor variables are too highly related, multicollinearity exists. The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable, and the standard errors for the coefficients can get very inflated (Dormann et al., 2013).

Computing the bivariate correlation for all measured variables is one of the practices to screen for multicollinearity. According to Katz (2011), the threshold of correlation coefficient between predictor variables, $r > 0.85$ is an appropriate predictor for collinearity, when it begins to severely distort model estimation and subsequent prediction (p. 90). As shown in Table 1, the predictor variables each represented an independent measure of the model showing no major concern of multicollinearity.

Table 1: Correlation Coefficients for the Predictor Variables

	Relative Advantage	Compatibility	Complexity	Observability	Trialability
Relative Advantage	1	.829**	.605**	.569**	.483**
Compatibility		1	-.588**	.643**	.539**
Complexity			1	-.541**	.560**
Observability				1	.584**
Trialability					1

Note. Correlation is significant at the 0.01 level (2-tailed) ***p* < .01.

Unfortunately, even if all correlations in the matrix are less than the threshold, this is no guarantee of not having a problem with multicollinearity. A major reason that the correlation matrix is inadequate for assessing collinearity is that a correlation matrix only provides information on the relationship between two variables. Katz (2011) suggested using the collinearity diagnostic routine in the linear regression program for calculating tolerance and variance inflation factor. SPSS (version 21) was used to calculate the variable tolerance and variance inflation factor (VIF) values for each predictor variable as a check for multicollinearity. If the variable tolerance is less than 0.1, or the VIF value is greater than 10, then there is a concern of multicollinearity. The results of collinearity diagnostic corroborated with the findings in the correlation matrix, which indicated that multicollinearity was not a concern (complexity, tolerance = .53, VIF = 1.91; observability, tolerance = .50, VIF = 2.01; trialability, tolerance = .56, VIF = 1.78; relative advantage, tolerance = 0.29, VIF = 3.4; compatibility, tolerance = .26, VIF = 3.80).

Hypothesis Testing

For this study, it was hypothesized that the attributes of innovation (relative advantage, compatibility, complexity, trialability, and observability) predict the probability of faculty adopting ARS into instruction. The null hypothesis was therefore defined as the following: The attributes of innovation (relative advantage, compatibility, complexity, trialability, and observability) do not significantly predict the probability of faculty adopting ARS into instruction. The hypothesis was tested by the means of binary logistic regression analysis.

The preliminary analysis of logistic regression involved evaluating the logistic model against the constant only model. Results of the analysis revealed that the constant only model suggested that if nothing was known about the predictor variables, one might guess a faculty member is a non-adopter and be correct 81.6% of the time. By adding the predictor variables, the full model was able to predict with an overall 92% accuracy (Table 2). The logistic model was good. The next steps evaluated significance and model fit.

Table 2: Binary Logistic Regression Classification of the Full Model Including the Five Attributes

			Predicted		
			Adoption of ARS		
	Observed		Adopter	Non-adopter	Percentage Correct
Step 1	Adoption of ARS	Adopter	25	12	67.6
		Non-adopter	4	160	97.6
	Overall Percentage				92.0

[a.] The cut value is .500

The model coefficient of the omnibus tests of model coefficients provides a measure of how well the model fits. The test of the full model, which includes all five predictor variables (relative advantage, compatibility, complexity, trialability, and observability), against a constant only model, was statistically significant, $X^2(5) = 80.544$, $p < .000$); therefore, the null hypothesis, which states that the model does not make a good prediction of the dependent variable, was rejected and the alternative hypothesis, which states that the model makes a good prediction of the dependent variable, was accepted. In addition, the Nagelkerke's R2 of .537 indicated a moderately strong relationship between predictions and grouping, which shows a well-fitted model. These findings were further supported by the results of the Hosmer-Lemeshow goodness-of-fit test, which confirmed the model fit the data. The results, X^2 (8) = 10.26, p = .25, revealed the computed chi-square statistics comparing observed frequencies with expected frequencies were non-significant, indicating the model is a good fit and fairly well predictive of the data. The case-wise listing of residuals did not reveal any case that did not fit the model well; therefore, the presence of outliers was not a concern. Together, these inferential statistics provided unanimous evidence supporting that the binary regression model, which included all the predictor variables (relative advantage, compatibility, complexity, trialability, and observability) fitted the data and the model significantly predicted the probability of faculty adopting ARS into instruction.

As shown in Table 3, the inferential binary logistical analysis examined the statistical significance of individual regression coefficients. Each respondent's answer to the items under each attribute was scored by calculating the means for each of the five attribute variables. Using the mean scale scores of the predictor variables, the binary logistic regression computation revealed that compatibility (p = .023) and trialability (p = .005) were statistically significant variables to predict the adoption of ARS into instruction. The odds ratio Exp(B) for compatibility (2.45) and trialability (1.57) predicted that as faculty's perception of compatibility of ARS increased one unit, the odds of adoption increased by 2.5 times. The odds ratio for trialability (1.57) predicted that as faculty's perception of trialability increased one unit, the odds of adoption increased by 1.6 times. In other words, individually, the constructs of compatibility and trialability were significant predictors of faculty's adoption of ARS ($p < .05$).

Table 3: Binary Logistic Regression Analysis of Innovation Diffusion Model Attributes Based on the Respondents' Adoption Decisions

	B	S.E.	Wald	*df*	*p*	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Relative Advantage	.356	.384	.859	1	.354	1.427	.673	3.028
Compatibility	.895	.393	5.185	1	.023*	2.447	1.133	5.285
Complexity	-.270	.255	1.119	1	.290	.764	.463	1.259
Observability	-.154	.312	.243	1	.622	0.857	.465	1.580
Trialability	.452	.161	7.859	1	.005*	1.572	1.146	2.156

Note. The binary dependent variable in this analysis is the answer (yes or no) to the survey question: At this time, do you consider yourself an adopter of the ARS? *$p < .05$

Discussion

This study examined factors influencing the adoption of ARS using the concept of perceived attributes described in Rogers's diffusion of innovation theory (Rogers, 2003). Based on data collected, this theory was used to explain the adoption decision of ARS by the faculty in a local university.

The significant findings were supported by the literature. For example, the studies by Banerjee, Wei, and Ma (2010), Hsbollah and Idris (2009), and Martins, Steil, and Todesco, (2004) found trialability was the most significant variable that influenced technology innovation adoption. Similarly, He, Duan, Fu, and Li (2006) found compatibility as the most significant predictor for the adoption of online e-payment in Chinese companies. Thus, the implication of these findings suggests that faculty need to be given the opportunity to pre-test the ARS prior to implementation. Trialability is the degree to which the faculty can test the technology before deciding whether to adopt it. The greater the opportunity to try a new technology, the easier it is for the faculty to evaluate it and ultimately adopt it (Rogers, 2003). However, trialability can be a challenge because testing with new technology may require the faculty to make substantial investments of time and effort before they can begin to experience the benefits. In addition, the perception of compatibility of ARS with existing instructional materials was considered an important factor affecting adoption as well. Compatibility is the degree to which the faculty perceives an innovation as being consistent with their existing values, needs, and experiences. The faculty needs to know how the technology will assist them in achieving their pedagogical goals. The faculty should be given the opportunity and support to exploit the instructional technology fully.

Although Roger's (2003) diffusion of innovation theory was developed to predict adoption of innovations according to potential adopters' perceptions of an innovation, the predictive power of each innovation attribute may vary with the nature of the innovation being studied and the context of the application. Therefore, the results of the study may only be applicable to ARS. It would be interesting to see if the attributes of compatibility and trialability remain the best predictors for the adoption of other type of instructional technologies. The perspective of this study was limited by surveying only the faculty at a local university. In order to have a more holistic view of the problem, future studies are recommended to explore different perspectives from other stakeholders who contribute to the process that may lead to the adoption of instructional technology. For example, it would be interesting to see if the students' perceived attributes of ARS are different from those of the faculty's perceived attributes. It is also interesting to examine the effects of ARS on students' academic performance across multiple disciplines.

References

Banerjee, P., Wei, K., & Ma, L. (2010). Role of trialability in B2B e-business adoption: Theoretical insights from two case studies. *Behavior & Information Technology, 31*(9), 815-827.

Bauer, J., & Kenton, J. (2005). Toward technology integration in the schools: Why it isn't happening. *Journal of Technology and Teacher Education, 13*(4), 519-546.

Bernard, R. M., Borokhovskil, E., Schmid, R. F., Tamim, R. M., & Abrami, P. C. (2014). A meta-analysis of blended learning and technology use in higher education: From the general to the applied. *Journal of Computers in Higher Education, 26,* 87-122.

Bingimals, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education, 5*(3), 235-245.

Brewer, C. A. (2004). Near real-time assessment of student learning and understanding in biology courses. *BioScience, 54*(11), 1034–1039.

Caldwell, J. E. (2007). Clickers in the large classroom: Current research and best-practice tips. *Life Sciences Education, 6*(1), 9–20.

Davidson, C., & Goldberg, D. (2010). *The future of thinking: learning institutions in a digital age.* Cambridge, MA: MIT Press. Retrieved from https://mitpress.mit.edu/sites/default/files/titles/free_download/9780262513746_Future_of_Thinking.pdf

Dormann, C. F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carre, G., . . . Lautenbach, S. (2013). Collinearity: A review of methods to deal with it and a simulation study evaluating their performance. *Ecography, 36*(1) 27-46.

Draper, S. W., & Brown, M. I. (2004). Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning, 20*(2), 81–94.

Efstathiou, N., & Bailey, C. (2012). Promoting active learning using audience response system in large bioscience classes. *Nurse Education Today, 32*, 91-95.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E. & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*, 423-435.

Fies, C., & Marshall, J. (2006). Classroom response system: A review of the literature. *Journal of Science Education and Technology, 15*(1), 101-109.

Frand, J. (2006). The information mindset: Changes in students and implications for higher education. *EDUCAUSE Review, 41*, March/April (13-14).

Gautreau, C. (2011). Motivational factors affecting the integration of a learning management system by faculty. *The Journal of Educators Online, 8*(1), 1-25.

Guse, D. M., & Zobitz, P. M. (2011). Validation of the audience response system. *British Journal of Education Technology, 42*(6), 985-991.

He, Q., Duan, Y., Fu, Z., & Li, D. (2006). An innovation adoption study of online e-payment in Chinese Companies. *Journal of Electronic Commerce in Organizations, 4,* 48-69.

Heaslip, G., Donovan, P., Cullen, J. G. (2014). Student response systems and learner engagement in large classroom. *Active Learning in Higher Education, 15*(12), 11-24.

Hixon, E, & Buckenmeyer, J. (2009). Revisiting technology integration in schools: Implications for professional development. *Computers in the Schools, 26*(2), 130-146.

Huang, Y. P. (2012). Diffusion innovation, perceived usefulness, perceived ease of use, and user acceptance of information technology. In *Proceedings of the 11th international conference on e-learning, e-Business, enterprise information systems, and e-government.* Retrieved from http://world-comp.org/p2012/EEE3490.pdf

Hsbollah, H. M., & Idris, K. (2009). E-learning adoption: The role of relative advantages, trialability and academic specialization. *Campus-Wide Information Systems, 26*(1), 54-70.

Katz, M. H. (2011). *Multivariable analysis: A practical guide for clinical and public health researchers* (3rd ed.). New York, NY: Cambridge University Press.

Kay, R. H, & LeSage, A. (2009). A strategic assessment of audience response systems used in higher education. *Australasian Journal of Education Technology, 25*(2), 235-249.

Keengwe, J. & Kang, J. J. (2012). Teaching with technology: Faculty adoption of educational technology. In P. Resta (Ed.), *Proceedings of society for information technology & teacher education international conference 2012* (pp. 4835-4839). Chesapeake, VA: AACE.

Keengwe, J., Onchwari, G., & Wachira, P. (2008). Computer technology integration and student learning: Barriers and promise. *Journal of Science Education & Technology, 17*(6), 560-565.

Lai, K. W., Khaddage, F. & Knezek, G. (2013). Blending student technology experiences in formal and informal learning. *Journal of Computer Assisted Learning, 29*(5), 414-425.

Laxman, K. (2011). A study on the adoption of clickers in higher education. *Australasian Journal of Education Technology, 27*(8), 1291-1303.

Lee, S. J., & Dapremont, J. A. (2012). Engaging nursing students through integration of the audience response system. *Nursing Education Perspectives, 33*, 55-57.

Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education, 16*(2), 233-263.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in educational research: From theory to practice.* San Francisco, CA: Jossey-Bass.

Long, J. S. (1997). *Regression models for categorical and limited dependent variables.* Thousand Oaks, CA: Sage Publishing.

Martins, C., Steil, A., & Todesco, J. (2004). Factors influencing the adoption of the internet as a teaching tool at foreign language schools. *Computers and Education, 42*(4), 353-374.

Martyn, M. (2007). Clickers in the classroom: An active learning approach. *Educause Quarterly, 30*(2), 71-74.

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

Nichols, M. (2008). Institutional perspectives: The challenges of e-learning diffusion. *British Journal of Educational Technology, 39*(4), 598-609.

Oigara, J., & Keengwe, J. (2013). Students' perceptions of clickers as an instructional tool to promote active learning. *Education and Information Technologies, 18*(1), 15-28.

Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., & Feinstein, A. R. (1996). A simulation study of the number of events per variable in logistic regression analysis. *Journal of Clinical Epidemiology, 49*(12), 1373-1379.

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon (MCB University Press), 9*(5), 1-6.

Preszler, R. W., Dawe, A., Shuster, C. B., & Shuster, M. (2007). Assessment of the effects of student response systems on student learning and attitudes over a broad range of biology courses. *CBE-Life Sciences Education, 6*(1), 29–41.

Project Tomorrow. (2011). *Learning in the 21st century: 2011 trends update.* Irvine, CA: Project Tomorrow.

Project Tomorrow. (2014). *Trends in digital learning: Students' views on innovative classroom models.* Irvine, CA: Project Tomorrow.

Revell, S., & McCurry, M. (2010). Engaging millennial learners: Effectiveness of personal response system technology with nursing students in small and large classrooms. *Journal of Nursing Education, 49*, 272-275.

Russell, J. S., McWilliams, M., Chasen, L., & Farley, J. (2011). Using clickers for clinical reasoning and problem solving. *Nurse Educator, 36*, 13-15.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Simpson, V. & Oliver, M. (2007). Electronic voting systems for lectures then and now: A comparison of research and practice. *Australasian Journal of Educational Technology, 23*(2), 187-208.

Schneckenberg, D. (2009). Understanding the real barriers to technology-enhanced innovation in higher education. *Educational Research, 51*(4), 411-424.

Southern Association of Colleges and Schools Commission and Colleges. (2012). *The principles of accreditation: Foundations for quality enhancement* (5th ed.). Retrieved from http://www.sacscoc.org/pdf/2012PrinciplesOfAcreditation.pdf

Stevens, J. P. (1992). *Applied multivariate statistics for the social sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Sultan, F., & Chan, L. (2000). The adoption of new technology: The case of object-oriented computing in software companies. *IEEE Transactions on Engineering Management, 47*(1), 106-126.

Tamim, R. M., Bernard, R. M., Borokhovski, E, Abrami, P. C., & Schmid, R. F. (2011). What forty years of research says about the impact of technology on learning: A second-order meta-analysis and validation study. *Review of Educational Research, 81*(1), 4-28.

Van Der Werf, M., & Sabatier, G. (2009). *The college of 2020: Students.* Washington, DC: Chronicle Research Services.

Vaterlans, J. M., Beckert, T. E., Fauth, E. B., & Teemant, B. (2012). An examination of the influence of clicker technology on college student involvement and recall. *International Journal of Teaching and Learning in Higher Education, 24*(3), 293-300.

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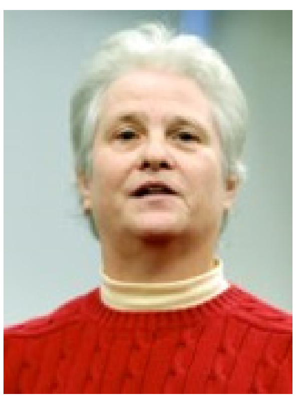

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