Use of iLearning in an Introductory Human Anatomy and Physiology Course

Michael C. Huisman and Katelin Michelle Valster

Corresponding Author: valsterk@central.edu

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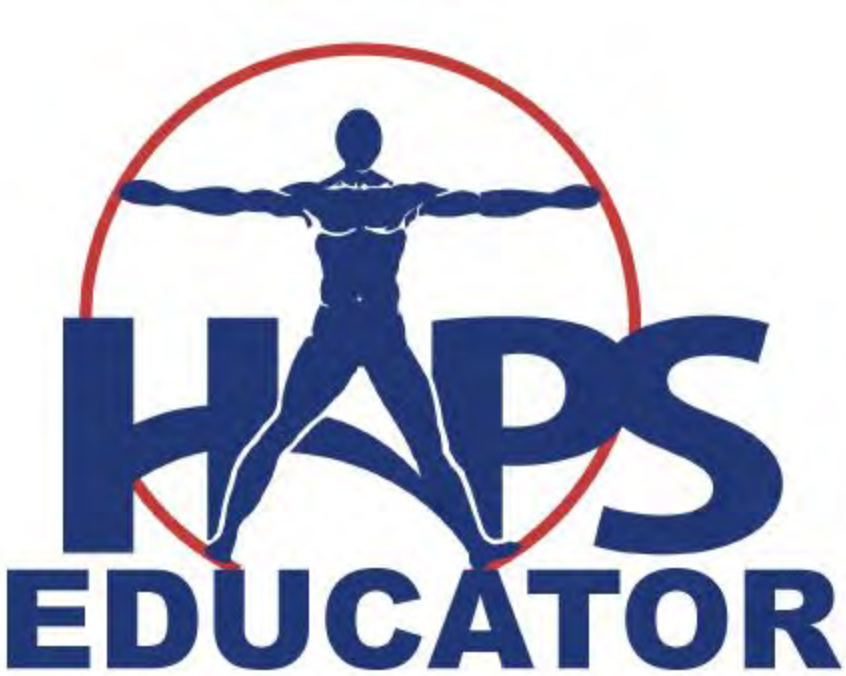

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Use of iLearning in an Introductory Human Anatomy and Physiology Course

Michael C. Huisman, DC, CSCS[1], Katelin Michelle Valster, PhD, CSCS[2]*
[1]Pella, IA 50219, mchuisman83@live.com
[2]812 University St #6600, Pella IA 50219, valsterk@central.edu
***Corresponding Author**

Abstract
The incorporation of mobile learning methods (iLearning) into human anatomy and physiology classrooms has been debated with regard to its effectiveness in higher education. This study aimed to understand how iLearning affects college-aged students' perception of learning and engagement in an introductory human anatomy and physiology course using a survey established by Rossing and coworkers (2012). Perceived learning was not significantly different from start to end of the semester while perceived engagement was significantly different in a negative direction. Mean scores were high for both dimensions at both time points which may have diminished meaningful interpretation. Nevertheless, the present study demonstrates that iLearning can be successfully implemented into higher education classroom settings while maintaining traditional classroom teaching and learning techniques. https://doi.org/10.21692/haps.2021.024

Key words: iLearning, classroom technology, anatomy course design, engagement

Introduction
The intersection of traditional classroom instruction styles with technology is a trend that is projected to continue (Raney 2016; Rossing et al. 2012). Technology has the potential to reach and engage students with varying learning styles, allowing expansion of possibilities in the classroom. Teachers can deliver a more customized education to students through technology (Johnson et al. 2011) and positively influence their academic success (Raney 2016; Rossing et al. 2012). The National Survey of Student Engagement (NSSE) identified technology as a significant and important trend for learning and skill building (BrckaLorenz et al. 2013). Active learning approaches, such as those that engage students in different ways to learn course concepts, presents a new opportunity for course design compared to traditional rote memorization laboratory activities (Griff 2016). Furthermore, the integration of tablets and app-related learning has shown a positive effect on student achievement and attendance (Wilkinson and Barter 2016). The integration of technology in the classroom provides several opportunities in undergraduate coursework.

There are different terms to reference technology and learning in the classroom. Mobile learning has been defined as the use of tablets, mobile devices, or other mobile technologies for learning (Jacob and Issac 2008; Traxler 2013). Similar yet distinctive from mobile learning, iLearning specifically incorporates Apple technology for education. This concept involves an intentional course design component through the use of supplementary technology, rather than serving as a substitute for teaching. For the purposes of this paper, iLearning refers to the use of iPads as the classroom technology intervention mode.

The current generation of students in residential college settings have exceptional intuition with technology; a majority use smartphones daily (Rossing et al., 2012). There is reason to assume students may prefer the use of technology for learning (Kvavik, 2005). Previous research indicates that students have held a positive attitude about using iPads for learning (Brand et al. 2011; Kinash et al. 2012; Perez et al. 2011; Rossing et al. 2012; Wakefield and Smith 2012). In a research study of over 4000 undergraduate students, most (41.2%) preferred classes with a moderate level of technology (Kvavik 2005). Moreover, having a major specific to the life sciences was found to be a predictor for preferring integration of technology into the classroom (Kvavik 2005). Teachers can reach the present generation of students through iLearning as most already have an intuitive mastery of technology.

Some research to date supports iLearning in human anatomy and physiology coursework. In a study of university anatomy courses, Wilkinson and Barter (2016) found tablet usage positively affected knowledge retention, application of knowledge, and/or a deeper understanding of difficult concepts. All assessment scores between traditional and mobile learning teaching strategies favored the use of iPads in the classroom (Wilkinson and Barter 2016). In another study of undergraduate students, Chakraborty and Cooperstein (2017) reported overall grade improvement when iPad apps were incorporated into the course. Moreover, there was a correlation between frequency of iPad use and course grade (Chakraborty and Cooperstein 2017).

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There is an opportunity to enhance the classroom environment and student outcomes by intentional integration of iLearning methods. Some evidence to support iLearning in anatomy and physiology coursework is available; however, Griff (2016) and Nguyen et al. (2014) call for more research in course design to best align teaching and learning. The purpose of this study was to determine if iLearning improved perceived learning and perceived engagement in undergraduate students enrolled in an introductory human anatomy and physiology course by addressing the following two research questions.

Does use of iLearning (use of iPads) in an introductory human anatomy and physiology course change student perceived learning outcomes? The researchers hypothesized perceived learning would increase after a semester of using iPads in the classroom.

Does use of iLearning (use of iPads) in an introductory human anatomy and physiology course change student perceived engagement outcomes? The researchers hypothesized perceived engagement would increase after a semester of using iPads in the classroom.

Methods

Institution Approval

This project was approved by the Central College Institutional Review Board (#H-02-F2018-CH and #H-04-F2019-CH) and informed consent was obtained from all participants.

Subjects

All recruited subjects were undergraduate students at a private, liberal arts school in the Midwest. A convenience sample of students enrolled in an introductory human anatomy and physiology course were recruited to participate in the study. Students were told that iLearning (use of iPads) would generally be incorporated into the class design and were asked to complete a survey at the beginning and end of the semester about their views of iLearning in the classroom. Participation was voluntary, anonymous, and had no effect on class evaluation outcomes. There were 92 students enrolled in the course: 51 male and 41 female. In total, 73 students participated in the study. Of those, 53 students (28 male, 24 female, and 1 did not disclose) completed both pre- and post-surveys (72.6% return rate) and were included in the data analyses. All students were between the ages of 18 and 28 years.

Procedures

The present study was a quasi-experimental mixed methods design. The use of iPads in an introductory human anatomy and physiology course was initiated in fall 2018. The researchers earned an institutional grant in order to purchase necessary equipment. Students were asked to participate in the study and complete a paper version of the Rossing et al. (2012) iLearning survey prior to the start of the first lab period. Lecture and laboratory iLearning activities were used to complement traditional teaching in the classroom throughout the semester; examples included use of app images, videos, and quizzes.

iLearning activities typically involved small groups, meaning no more than 3 students to an iPad. Specifically, on handouts in lecture or lab, students were asked to identify structures within the app utilizing different 3-dimensional views, ascertain content from videos to complete sentences or aid in class discussion, or take randomized (but not graded) small group quizzes on the app to reinforce repetition in learning anatomy. It was estimated iLearning accounted for 30 minutes out of a possible 4 hours and 5 minutes per week of in-class activities. During the final lab period students were again asked to complete the iLearning survey.

Measures

Quantitative and qualitative data were collected using the iLearning survey created by Rossing et al. (2012; Appendix 1) and permission to use the survey was granted by Jonathan Rossing (Appendix 2). The survey includes 12 Likert-scale questions categorized into 2 dimensions: student perceived learning or student perceived engagement. Additionally, open-ended questions about iLearning were also asked on the survey.

Quantitative Scoring

The 12 survey questions were assessed on a Likert scale from *strongly agree* (5) to *strongly disagree* (1). Questions 1 through 6 reflected student perceived learning and questions 7 through 12 reflected student perceived engagement.

Psychometric properties

No psychometric properties were available for the survey. Additionally, aggregate course grades (percentages) were de-identified and collected by semester. Then, grade averages were compared for the 3 semesters before iLearning implementation in the course and the 3 semesters after the intervention.

Data Analysis

All quantitative data were analyzed using Statistical Package for the Social Services (SPSS) version 26 (IBM, Armonk, NY). Student paired t-tests were used to analyze any change to student perception of learning pre-iLearning intervention to post-intervention and any change to student perception of engagement pre-iLearning intervention to post-intervention. Moreover, Student's paired t-tests were used to further analyze individual questions on the survey to determine specific changes within the dimensions of learning and engagement. An *a priori* level of .05 was set to determine statistical significance.

A content analysis was performed on the survey open-ended responses using techniques described by Ryan and Bernard (2003). The coding process involved reading the open-ended survey answers; the first time without note taking while the

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second time involved highlighting common or repetitive ideas and themes. A comparison method was then used to distinguish opportunities and limitations described by the subjects and these were grouped by identified themes. This qualitative information was then utilized to best make meaning of the quantitative data.

Results

There was a significant difference ($p < 0.001$) in perceived engagement from the beginning ($M = 25.79 \pm 4.67$) to the end ($M = 22.32 \pm 3.88$) of the semester. There was no significant change ($p = 0.540$) in perceived learning from the beginning ($M = 25.19 \pm 3.09$) to the end ($M = 25.49 \pm 3.66$) of the semester. Data is summarized in Table 1.

	Time	Mean	Std. Deviation	*p*-value
Perceived Learning	Pre-	25.19	3.09	0.540
	Post-	25.49	3.66	
Perceived Engagement	Pre-	25.79	4.67	< 0.001
	Post	22.32	3.88	

Table 1. *iLearning survey results by dimension.*

Further analysis showed significant differences for 3 specific questions asked on the survey (Table 2). Regarding the perceived learning dimension, student confidence in course content (question 5) increased ($p = 0.018$) through the use of the iPad and associated activities. With respect to perceived engagement, questions 8 and 10 showed a significant change ($p = 0.041$ and $p < 0.001$, respectively). For question 8, students expressed a reduction ($p = 0.041$) in their perceived participation in class with the iPad at the beginning of the semester ($M = 3.54 \pm .93$) compared to the post-data collection ($M = 3.19 \pm .98$). Responses to question 10 revealed that students found the iPad technology to be more convenient ($p < .001$) than using a standard computer when surveyed at the end of the semester.

Question	Time	Mean	Std. Deviation	*p*-value
5	Pre-	3.96	.76	0.018*
	Post-	4.25	.71	
8	Pre-	3.54	.93	0.041*
	Post-	3.19	.98	
10	Pre-	3.74	.88	<0.001**
	Post-	4.32	.61	

*significant at $p < .05$
**significant at $p < .001$

Table 2. *iLearning survey results by question*

Aggregate course grades were 82.41 $\pm$ 11.77% before and 82.97 $\pm$ 8.19% after iLearning strategies were implemented.

Five themes were established through qualitative analysis: access and availability, sharing and collaboration, novelty, learning style, and convenience. Students had more positive (opportunities) than negative (limitations) comments for each theme except for convenience. When the comments for iLearning were analyzed based on the perception of convenience, 32 were considered positive reflections of the intervention whereas 33 comments were stated as a negative. Of the comments that viewed iLearning as a positive addition to the course, 61.5% (n=32) noted the iPads and app as effective tools for the content covered and 37.7% (n = 20) stated that the interactive nature of the app increased involvement. The top limitation to iLearning was that the technology could be uncooperative at times (e.g., touch sensitivity, screen freeze), mentioned by 41.5% (n=22) of the sample. A summary of the most common comment for each qualitative theme is shown in Table 3.

Theme	Comment	Percentage (n)	Opportunity or Limitation
Access & availability	Effective tool for content	61.5% (32)	Opportunity
Convenience	Uncooperative technology	41.5% (22)	Limitation
Learning styles	Interactive and increases involvement	37.7% (20)	Opportunity
Novelty	New way to learn	26.4% (14)	Opportunity
Convenience	Easy to use	26.4% (14)	Opportunity
Sharing	Make connections in new ways	22.6% (12)	Opportunity
Sharing	Difficult to use in small groups	18.9% (10)	Limitation

Table 3. *iLearning themes identified through qualitative analysis.*

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Discussion

The purpose of this study was to determine if iLearning improved perceived learning and perceived engagement in undergraduate students enrolled in an introductory human anatomy and physiology course. We found that the use of iLearning activities did not change perceived learning but did significantly affect perceived engagement. However, the results indicated that the significant change to engagement was negative, meaning students perceived less overall engagement through iLearning than what they had expected at the start of the semester. At both time points, there was a strong and significant correlation between perceived learning and perceived engagement through the use of iPads in class. Therefore, the research hypotheses were not accepted.

Perceived Learning

Perhaps the absence of a change in perceived learning with iLearning activities was due to the creation of a ceiling effect by the mean scores at pre-data collection, leaving little room to improve toward the 30-point maximum on the survey scale. It is possible students overstated their perceived learning at the start of the semester and, in fact, realized a high level of learning through iPad activities for the duration of the semester. Compared to the original study by Rossing and coworkers (2012), mean scores for this dimension were higher for every question except number 3. Therefore, the students' initial, relatively positive perception of how iLearning could augment their learning may have diminished any intervention effect seen after using the technology.

Confidence (question 5) was the only construct in the perceived learning dimension to significantly increase from start to end of the semester. iLearning expands the possibility in the classroom by offering a hands-on option for a wide range of student abilities, which allows individuals to move through the material at their own pace. In a study of undergraduate students enrolled in an introductory human anatomy and physiology course, a majority (78%) indicated the use of an iPad improved mastery of content (Chakraborty and Cooperstein 2017).

Similarly, 20 students (37.7%) in the present study appreciated the ability of the interactive, 3-dimensional pictures to help them visualize complex concepts when using the iPad. It has been shown that students perceive an increased effectiveness of learning through computer-based interactive imagery compared to paper-based static imagery (Khalil et al. 2005). By integrating iLearning strategies, students control their learning process rather than relying completely on knowledge transfer from faculty (Bailey et al. 2015). Thus, students can gain confidence in course content through self-paced and interactive learning methods. Innovative approaches to improve collaborative learning changes the traditional classroom and offers the student more influence on their learning as opposed to a teacher-driven model.

Research suggests connecting iLearning in the classroom to course objectives is an effective way to reach students and augments student-faculty interaction (Rossing et al. 2012; Sample 2011; Wilkinson and Barter 2016). Rossing and colleagues (2012) studied combined teaching styles and found students perceived the use of tablets to be helpful to the learning process. Specifically, students reported the ability to connect to ideas in new ways and that tablets provided additional opportunities to apply course content to solving problems (Rossing et al. 2012).

In the present study, the constructs of content application, learning, and connecting new ideas were not significant between the pre- and post-surveys. However, the survey question means were very high at both time points. In fact, of the 636 responses in this survey dimension, only 31 were either *disagree* or *neutral* on the Likert scale. Therefore, the present study may reflect that the students sampled were open to perceived learning through iLearning teaching strategies from the start of the semester. The introduction of technology does take intentional design, but the opportunity exists to incorporate a high-impact practice to supplement teaching pedagogy.

Conversely, the integration of iLearning may have had a non-significant effect on perceived learning due to inherent shortcomings of the technology and its accessibility. The iPads were only available during class or the professor's office hours. This time constraint may have limited how students could apply, connect, or participate with iLearning methods. Moreover, the use of tactile learning with anatomical models was condensed to provide time for integration of new iLearning activities. Students have been shown to enjoy the tactile sensation of using an actual anatomical model (Yammine and Violato 2015). Finally, for any interface, time is often needed to gain comfort in the intricacies of how it works, no matter how intuitive the student of today is with screen-based technologies. In fact, uncooperative technology was the most commonly expressed limitation, noted by 22 subjects (41.5%). Future research should consider evaluation of best practices to understand preferences and the association to course outcomes through the integration of multiple sensory approaches in a traditional undergraduate classroom.

Perceived Engagement

There was a significant, negative change in perceived engagement throughout the semester; meaning that students noted less engagement through iLearning at post-data collection than what they had anticipated at the start of the semester. In contrast to the original study by Rossing and coworkers (2012), the only significant changes seen throughout the semester were in questions 8 and 10. For question 8, students felt they participated less with the iPads than expected. This group of students may have preferred more traditional learning methods to iLearning, leading to the present study results. Answers to question 10 at post- data

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collection indicated that students felt the iPad was a more convenient iLearning device compared to a traditional laptop or computer compared to at the beginning of the semester. Moreover, 32 students (61.5%) agreed that iLearning activities were an important and effective tool for the course. However, the group difference seen for perceived engagement by the end of the semester in the present study was ultimately significant in a negative direction. It is possible the high survey scores at the beginning of the semester prevented any meaningful change to be seen.

Previous research has shown that technology may afford the personalization of learning by offering students autonomy and empowerment in the process no matter the number of students enrolled in a course (Wilkinson and Barter 2016). Sample (2011) found that the use of technology in course design may be able to adapt to a variety of faculty to student ratios to ensure student engagement remains high while keeping the focus on course content. Class size may have played a role in the unexpected results in perceived engagement.

In the present study, the typical ratio of students per iPad ranged from 1 to 3 at any given time. Ten iPads were available for iLearning with an average lecture size of approximately 23 students and an average lab size of about 15 students. Because these students did not have a personal iPad throughout the semester, their perceived engagement may have been stifled. Specifically, 22.6% (n = 12) of students provided a negative response to question 8. These students felt they participated less in class with the iLearning activities than activities without. And 10 students (18.9%) commented that it was difficult to complete the iLearning activities in small groups. This was despite the other opportunities mentioned, such as the convenience of using an iPad versus a computer or the larger screen size compared to using an app on a standard cell phone. Ultimately, the design of this introductory human anatomy and physiology course includes a variety of teaching strategies to engage students. As a whole, there was a negative, significant change in perceived engagement due to iLearning. However, the results showed some support of multiple teaching methods rather than an over-reliance on iLearning.

Previous research has shown that instituting group work with technology bolsters confidence in and overall understanding of course content (Laal and Ghodsi 2012). Examples of group work in the present study included identification of structures through the images provided in the app, watching videos explaining human physiology of specific systems, and trying randomized quizzes by completing worksheets while using the iPads. There was a slightly greater but non-significant improvement in student responses to question 11, wherein there was a positive indication of collaboration using an iPad compared to other group activities. Moreover, 14 students (26.4%) appreciated the new way to learn content and 12 students (22.6%) stated that iLearning allowed them to make connections to course content while working with their peers. Likewise, previous research showed that mobile technology provided greater opportunities for collaboration and dynamic learning (Rossing et al. 2012). Again, the negative change may reflect a preference for learning through other forms of engagement or a consequence of the fact that signal measurements at the start of the semester were quite high.

Only 24 responses for the entire dimension were either *disagree* or *strongly disagree*. As stated earlier, the current generation of students is intuitive with touch screen technology. However, interaction with iLearning requires a slight learning curve and these activities can lead to frustration. Rossing et al. (2012) indicated undergraduate students use smartphones but may not have the capacity to apply those skills to critical thinking situations. Furthermore, with the typical student-to-iPad ratio mentioned above, the comfort levels of individual students may have varied. The instructors provided specific, guided classroom activities in an attempt to increase comfort and engagement without frustration. These factors may, in part, be responsible for the negative changes to the dimension of perceived engagement after a semester of iLearning. Instructors looking to add iLearning to their courses should ensure familiarity with the technology before activities and assessments occur.

Student perceptions of the convenience of iLearning (question 10) were significantly changed in a positive direction. Previous studies found that students believed iPads to be a useful tool to increase flexibility, portability and productivity because they are small in size and easy to use (Alyahya and Gall 2012; Rossing et al. 2012). Perez et al. (2011) found student perceptions were positive about using iPads in their learning, but there was no evidence of better learning outcomes. In the present study, the aggregate class final average grade did not significantly change after implementation of iLearning. Future research could focus on finding how iLearning can benefit student retention of specific introductory human anatomy and physiology course objectives through analysis on measurable course evaluations.

Conclusion

Technology will continue to shape our everyday lives and the undergraduate classroom is not exempt. Educators must continually evaluate technology's effectiveness and pedagogical applications. This study sought to build upon the growing body of research regarding the perceived effectiveness of technology, specifically iLearning, in the classroom. In summary, the addition of iLearning did not result in significant, positive changes to perceived learning and perceived engagement through an academic semester. However, responses to both perceived learning and engagement at both time points were mostly on the positive end of the survey Likert scale. Therefore, the use of iLearning in an introductory human anatomy and physiology course is encouraging, though additional research is needed to establish best pedagogical practices to maximize both perceptions and outcomes.

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About the Authors

Michael "Cody" Huisman, DC, CSCS, was most recently an assistant professor of Exercise Science at Central College. He taught courses in human anatomy, physiology and kinesiology. Cody's research interests include functional movement patterns as they relate to athletic performance and improving pedagogy through technology.
Katelin Valster, PhD, CSCS is a lecturer of Exercise Science and a pre-health and post-graduate advisor. Her research interests include community health education program implementation, psychological and physiological influences on sport performance, and teaching pedagogy (i.e., service-learning).

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APPENDIX 1: iLearning Survey

You are invited to participate in a survey to get your feedback on the effects of using iPads in the classroom. Your participation is completely voluntary and anonymous. Whether or not you complete this survey will have no bearing on your grade in this class. You may choose to skip any question you do not want to answer and stop completing the survey at any time.

Select how strongly you agree or disagree with the following statements.

The iPad activity (OR a specific application) may help me	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. apply course content to solve problems.					
2. learn the course content.					
3. connect ideas in new ways.					
4. participate in the course activity in ways that enhanced my learning.					
5. develop confidence in the subject area.					
6. develop skills that apply to my academic career and/or professional life.					
7. The iPad activities will motivate me to learn the course material more than class activities that do not use the iPad.					
8. I will participate more in class during the iPad activities than during activities that did not use the iPad.					
9. My attention to the task(s) will be greater using the iPad.					
10. The iPad is more convenient compared to a desktop or laptop computer					
11. It is easier to work in a group using the iPad than in other group activities.					
12. iPad activities will be an important supplement to this class.					

13. Describe how the iPad activity may help or limit your learning of the class content.

14. Describe at least 2 things you anticipate liking about using iPads in this class:

    a.

    b.

15. Describe at least 2 things you anticipate disliking about using iPads in this class:

    a.

    b.

Tell us about yourself

16. Age	Under 18	18 – 28	29 – 44	45 and over
17. Gender	Female		Male	

18. Before using iPads in this class, what was your comfort level using handheld mobile computing devices?

    [ ] Not at all comfortable

    [ ] Not very comfortable

    [ ] Fairly comfortable

    [ ] Very comfortable

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19. How likely are you to use a handheld mobile computing device for e-learning or professional development?

[ ] Not likely

[ ] Somewhat likely

[ ] Likely

[ ] Extremely likely

[ ] Unsure

20. Considering face-to-face classes that use e-learning technology [such as handheld devices, online research guides, Oncourse, or other course management systems] in the classroom, which of the following best first your preference?

[ ] Classes that make little or no use of e-learning technology.

[ ] Classes that use a moderate amount of e-learning technology.

[ ] Classes that make extensive use of e-learning technology.

[ ] No preference.

21. Do you own a handheld mobile computing device that is capable of accessing the Internet (whether or not you use that capability)? Examples include iPhone, BlackBerry, other Internet-capable cell phone, iPod touch, PDA, iPad, Kindle, etc.

[ ] No, and I don't plan to purchase one in the next 12 months.

[ ] No, and I plan to purchase one in the next 12 months.

[ ] Yes.

[ ] Don't know.

22. If yes, how do you use handheld mobile computing devices? Check all that apply.

[ ] Access course management systems

[ ] Access other e-learning tools

[ ] Browse the Internet

[ ] Download and listen to music

[ ] Download and listen to podcasts/audio books

[ ] Download and read e-books/print-based content

[ ] Download and view streaming movies/video clips

[ ] Make phone calls

[ ] Play interactive games

[ ] Search for information

[ ] Send and receive e-mail

[ ] Send and receive instant messages (IMs)

[ ] Send and receive pictures (MMS)

[ ] Send and receive short text messages (SMS)

[ ] Use camera to take and share pictures

[ ] Banking

[ ] Calendar

[ ] Maps

[ ] News

[ ] Shopping

[ ] Social networking

[ ] Sports

[ ] Twitter

[ ] Weather

[ ] YouTube

[ ] Other. Please specify: _____
_____

The survey is borrowed from:

Rossing, J.P., Miller, W.M., Cecil, A.K., and Stamper, S.E. (2012). "iLearning: The future of higher education? Student perceptions on learning with mobile tablets". *Journal of the Scholarship of Teaching and Learning, 12*(2), p. 1-26.

Permission for reproduction and use of the survey was granted on June 25, 2018.

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APPENDIX 2

Permission to use the Rossing et al. (2012) iLearning survey:

-------- Original message --------
From: "Rossing, Jonathan" <rossing@gonzaga.edu>
Date: 6/25/18 1:47 PM (GMT-06:00)
To: Katelin Gannon <gannonk@central.edu>
Subject: RE: iPad technology survey

Hello Katelin,
Thanks for your message.
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Jonathan

JONATHAN P. ROSSING, PhD | Gonzaga University | Associate Professor and Department Chair, Communication Studies | P 509-313-6958 | rossing@gonzaga.edu
GONZAGA UNIVERSITY

Back to TOC