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Increasing Student Engagement and Knowledge Retention in an Entry-LevelGeneral Nutrition Course with Technology and Innovative Use of a Graduate-Level Teaching Assistant

Minhee Kang
Utah State University

INCREASING STUDENT ENGAGEMENT AND KNOWLEDGE RETENTION IN AN ENTRY-LEVEL NUTRITION COURSE WITH TECHNOLOGY AND INNOVATIVE USE OF A GRADUATE-LEVEL TEACHING ASSISTANT

by

Minhee Kang

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Approved:

_____	_____
Heidi Wengreen, Ph.D. Committee Member	Marlene Israelsen Graf, M.S. Committee Member
_____	_____
Kerry A. Rood, M.S., DVM Committee Member	Mark R. McLellan, Ph.D. Vice President for Research and Dean of the School of Graduate Studies

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ABSTRACT

Increasing Student Engagement and Knowledge Retention in an Entry-Level General Nutrition Course with Technology and Innovative Use of a Graduate-Level Teaching Assistant

by

Minhee Kang, Master of Science

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Major Professor: Dr. Heidi Wengreen
Department: Nutrition, Dietetics, and Food Sciences

Higher student enrollment rates and evolving student expectations are current challenges for many universities. Today's students expect teaching pedagogy that integrates technology and offers flexibility. Blended course designs provide both of these things because they include both face-to-face and online learning opportunities. Utilizing web-based learning platforms, now offered by many college textbook publishers, can also enhance a student's online learning experience and performance.

This research focuses on a blended-design general education nutrition course offered at Utah State University (USU). Prior to Fall 2015, "Mastering" (Pearson Publishing) was the web-based learning platform being used in this course. A separate study, completed in 2015, assessed the efficacy of Mastery over two consecutive semester periods and concluded that it was ineffective in increasing students' final letter

grade or improving knowledge retention. As a result, Mastering was replaced by a new web-based learning platform, called “Connect” (McGraw Hill Publishing).

One of the purposes of this study was to evaluate Connect. Students who used Connect earned higher final grades and showed increased knowledge retention rates at the end of the semester compared to students who had used the old platform (Mastering). When below-average and above-average pre-test score groups were compared, there was no statistical difference between Mastering and Connect on students' knowledge retention rates on a post-test administered 4 months after course completion. We also found that, like Mastering, the knowledge retention rate for students who used Connect increased the most among the students who scored the lowest on an initial assessment of nutrition-related knowledge.

One complaint of blended courses that students often report is a feeling of disconnection or decreased engagement. A second part of this research measured self-reported rates of student satisfaction and engagement to determine the effect, if any, of additional technological tools (Google+, for example) and greater interaction and support from a graduate-level teaching assistant (TA).

Compared to the class without the additional tools and TA support, final grade, course satisfaction level, and student attendance rate improved in the classes that did incorporate these things. A student engagement survey was given at the beginning and end of the semester to measure the change in the engagement level during the semester. Interestingly, freshman students earned higher final grades than upper classmen and student engagement rates decreased as the semester progressed.

Overall, the Connect platform and the additional tools and TA support had desirable effects, including greater student-reported levels of course satisfaction and improved academic performance. Also, it appears that these additional components helped at-risk students the most – especially freshmen students and students who scored low on the pre-test that measured existing nutrition knowledge at the beginning of the course.

(117 pages)

PUBLIC ABSTRACT

Increasing Student Engagement and Knowledge Retention in an Entry-Level General Nutrition Course Using Technology and a Graduate-Level Teaching Assistant

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Blended-design courses integrate both face-to-face and online learning. This thesis discusses the use of three teaching innovations and their effect on student engagement and course satisfaction in a blended-design nutrition course. The three teaching innovations include 1) a web-based learning platform, called Connect (published by McGraw-Hill Education) 2) other easily-accessible technological tools (such as Google+), and 3) higher-level use of a graduate-level teaching assistant.

Another form of web-based learning platform, Mastering, published by Pearson Education, was use previously in the course. However, students, especially those earning the highest grades in the course, did not see value in completing these assignments as a way to help them to learn the material. The experience of students using Mastering was compared to the experience of students using Connect. When student's retention of information taught in the course was assessed four months after the courses ended. Students who had used the Connect platform performed similarly to students who had used the Mastering platform. In addition, like Mastering, retention of the information was best among the students who had low levels of nutrition knowledge at the beginning of the semester. Other tools such as Google+ and a teaching assistant were used in a second study to increase the feeling of engagement in the blended learning class. Compared to

the class without the extra tools, final grade, course satisfaction level and student attendance rate improved. Interestingly, with the extra tools, freshman students earned the highest final grade than a sophomore, junior and senior student group. A student engagement survey was given in the beginning of the semester and at the end of the semester. It was surprising that student engagement decreased across the semester. Both studies created desirable effect such as greater student course satisfaction level and the improved academic performance. Also, it appears that the tools implemented in both studies helped at risk students more than students who came to the class with a higher the most, such as freshman students and/or the students who have lack of fundamental knowledge when entering the course.

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Minhee Kang

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CHAPTER I

INTRODUCTION AND BACKGROUND

Abstract

Current challenges of institutes of higher education include rising enrollment and changing student expectations that includes teaching pedagogy that integrates technology and offers flexibility that is student centered. Blended course designs that include both face-to-face and online learning opportunities are one way to address these challenges. The Science and Application of Human Nutrition, was first offered in a blended format in Fall of 2011. The goal of the blended design was to maximize the advantage of both traditional teaching and the online teaching that will satisfy the expectations of students while allowing the department to accommodate increasing student enrollments. However, one of the major known limitations of blended learning is decreased interaction between students and instructors and among peers, which lead to decreased student's engagement in learning. The NDFS 1020 course has utilized the online learning platform known as Mastering by Pearson education. Assessment of student learning with this platform was previously assessed and results were not acceptable. The aims of this study are twofold: First, this study will ascertain whether the use of new web-based platform Connect will increase retention of basic nutrition concepts compared to old web-based platform Mastering in the online/blended learning environment of NDFS 1020. Second, this study will also assess the use of a TA to purposely deliver activities designed to enhance

student engagement above and beyond the activities and contacts provided in the typical design of the course throughout the semester.

Purpose Statement

Current challenges of Utah State University (USU) and other institutions of higher learning include higher enrollment rates and evolving student expectations. Many college students now expect teaching pedagogy that integrates technology, offers flexibility, and is student-centered. Instructors are seeking for learning strategies and tools that will effectively and efficiently increase student learning and performance. Many instructors are incorporating web-based learning platforms and other online resources offered by textbook publishers. Although this content provides students with customized and real-time feedback, students may feel isolated and un-supported if too much of the learning is dependent on these resources. The purpose of this thesis is to1) evaluate whether the use of a new web-based platform, called Connect (McGraw Hill), will increase knowledge retention rates of basic nutrition concepts compared to the web-based platform that was previously used (Mastering, developed by Pearson) in an online/blended learning General Nutrition Course (NDFS 1020: The Science and Application of Human Nutrition) and 2) assess the effectiveness of using a graduate-level Teaching Assistant (TA) to incorporate and manage additional study sessions and activities on student engagement.

Background

Expectations of Learners in the 21st Century

Universities are faced with rising enrollment and learners who have been raised in a technology-driven society. Millennials (those born between 1980 and 2000), have been

accustomed to technology being implemented in most aspects of their primary and secondary education (Means et al., 2009). The integration of technology in classrooms and flexible learning environment to fit into the busy lifestyle is more likely to meet the expectations of Millennials.

The Institute of Education Sciences reports that the enrollment rate in degree-granting institutions increased by 15 percent between 1992 and 2002. Between 2002 and 2012, enrollment increased 24 percent, from 16.6 million to 20.6 million (Snyder and Dillow. 2016). Also, the number of 18- to 24-year-olds increased from 28.5 million to 31.4 million (a 10% increase) and the percentage of 18- to 24-year-olds enrolled in college rose from 37 percent in 2002 to 41 percent in 2012 (Snyder and Dillow. 2016).

Studies show that growth in the number of on-line degree programs has been attributed to the increased number of student enrollees who want to take courses that will positively impact their future careers but not hinder family and work responsibilities (Bangert, A.W. 2004; Maeroff G. I. 2003). The U.S. National Center for Education Statistics also reports that in 2015, one in ten students were enrolled exclusively in online courses (Snyder and Dillow. 2016). Studies conducted by the Babson Research Group also acknowledge that 7.1 million American students are engaged in online learning in some form (Johnson et al., 2015).

However, there are limitations to an online environment as a teaching and learning tool. In an online delivery format, synchronized, face-to-face interaction is often absent and university instructors often need to rethink the roles of the teacher and the learner (as they are typically defined in a traditional classroom environment) and adjust the course design to effectively reach desired learning outcomes (Conceição, 2007).

Blended Learning

A blended course combines traditional learning (a synchronous face-to-face experience in a classroom or IVC setting) with online learning (an asynchronous experience). At Utah State University (USU), a blended course is defined as one where online (asynchronous) participation is between 21 and 79 percent and the remainder is traditional (synchronous in a classroom or IVC setting) (Utah State University Center for Innovative Design & Instruction, n.d). Blended learning was introduced to the USU campus as a way to bridge and maximize the strengths and advantages of both traditional and online teaching.

The U.S. Department of Education published a meta-analysis of the research on blended learning in 2010, which found that students performed better in courses that included an online component compared to those in traditional face-to-face courses. The report noted that blended courses often included additional learning time and provided instructional elements that were not available to students in face-to-face or fully-online classes (Means et al., 2009).

A research review published by Kaplan Inc. also found that blended learning courses can potentially offer more personalized, student-focused, and flexible forms of teaching than traditional face-to-face-only settings (Bullmaster-Day, 2011).

While the effectiveness of blended learning models varies from course to course, it has become clear that there is a demand from students for learning opportunities that are more accessible and Blended-design courses offer this. However, blended design also requires high quality support at all levels: organizational infrastructure, well organized course format to effectively deliver the course material, faculty development to have

instructors who are knowledgeable in the environment; as well as consistent student learning support mechanisms that will help the students to be aware of the responsibilities and additional demands of the online setting (Carr, 2014; Moskal et al., 2013). Even though there is increased opportunity for synchronized sessions, a lack of face-to-face interaction between students and an instructor compared to the traditional face-to-face classes is still one of the generally accepted limitations of blended design learning. Also, generally, access to instructors and teaching assistants through office hours or other means is often less readily available in web-based classes (Wang and Newlin, 2002).

A lack of interaction between instructors and peers often results in feelings of isolation among students, which is associated with decreased academic engagement and performance (Wang and Newlin, 2002; Artino and Jones, 2012; Cho and Summers, 2012). Studies suggested that the lack of interaction and feelings of isolation are main contributors to a high dropout rate in online courses (Wang and Newlin, 2002; Lee and Choi, 2011; Willging and Johnson, 2009). This high dropout rate among online students has been a long-standing concern and problem among educators.

Feelings of isolation can affect a student's self-confidence and discourage them from registering for additional online courses. In addition, low completion rates can lead to a loss of profits for institutions. If completion rates could be improved, it may suggest that the quality of the course has improved and institutions would make better use of resources without waste and administrators could plan budgets for future fiscal years more efficiently (Banna et al., 2015).

One study measured student engagement in online courses by comparing participation in active activities (discussion forums, labs and group projects, research

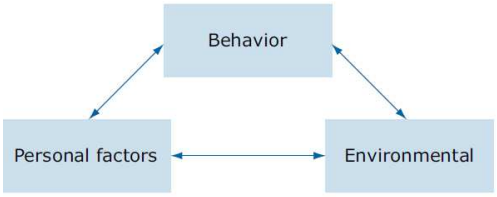

Figure 1: Social Cognitive Theory Model (Bandura, 1986)

papers, and current events assignments.) or passive activities (reading, taking quizzes, watching/looking at PowerPoints or video lectures). The study concluded that there was no significant difference in student engagement levels between the two. Instead, it was suggested that participation in multiple communication channels may correlate more with higher rates of engagement. It was also noted that, in general, there is a strong and clear correlation between student-to-student and instructor-to-student communication and student engagement within a course. This study recommended that online instructors use active learning activities but focus more on communication and interaction between and among students. Incorporating meaningful and multiple ways of interacting with students and encouraging/requiring students to interact with each other (Dixson, 2010).

Social Cognitive Theory in Behavior Change

Bandura's Social Cognitive Theory (BSCT) proposes that people are driven not by inner forces, but by external factors (Bandura, 1986). This model suggests that human functioning can be explained by a triadic interaction of behavior, personal factors, and environmental factors (See Figure 1). This is often known as reciprocal determinism. Environmental factors represent situational influences. Environment in which behavior is

preformed while personal factors represent affective, cognitive and biological matters that can motivate or discourage the behavior change (Bandura, 1986). BSCT was applied for the continued development of the Science and Application of Human Nutrition (NDFS 1020) course design. For this study, the environmental factors can be improved by 1) offering appropriate support from an instructor and a TA and 2) providing an effective and user-friendly web-based learning platform. When the environment factors are improved, it is likely to lead to high self-efficacy of students, believing in self that the one can complete the task correctly. Students with high self-efficacy are more likely to be engaged with the course materials of NDFS 1020 and will change the individual learning behavior. The positive change in the students' behavior (keeping up with readings, participate in review sessions) will be reflected in higher final grades and higher-class completion rate.

NDFS 1020

The Science and Application of Human Nutrition (NDFS 1020), taught in a blended-design implemented a web-based learning platform in Fall 2013 and Spring 2014 in the hope of improving student learning outcomes, including the retention of information. The web-based platform is a tutorial program that included a comprehensive teaching tool that reinforces concepts discussed in course readings, assignments, and lectures through different pedagogy such as Socratic questioning (progressive questioning) and metacognition (the use of self-reflection as part of a course of study). However, the Mastering program showed to be an ineffective tool in increasing overall letter grade of students during two consecutive semesters. Also, there were no differences in mean scores at pre, final, or posttests between groups that were given to measure

information retention rate. The study concluded that the use of a web-based platform as part of the NDFS 1020 course structure should be re-evaluated and it seems to be costing students more time and money than the benefit observed in this group (Litchford, 2015).

As the e-textbook market continues to evolve, teaching and learning through web-based learning platform is becoming a popular complementary method of conventional teaching and learning approaches, especially in high enrollment courses such as general nutrition. These web-based learning resources are touted by book publishers to produce a more meaningful learning experience by enhancing students' knowledge retention thus improve students' academic performance (Jaaman et al., 2013). The instructors of NDFS 1020 reviewed the available textbook and accompanying web-based learning platforms and selected the Human Nutrition: Science for Healthy Living Text by Stephensen and Schiff and Connect platform by McGraw-Hill Education because the learning objectives addressed seemed to be a good fit for the USU NDFS 1020 course.

Connect is a web-based assignment and assessment platform. It uses digital technology and adaptive learning techniques to better connect professors to their students, and students to their course materials in an easy-to-use online site. Adaptive learning techniques include SmartBook give adaptive "highlighted" reading that emphasizes critical content decided by the authors. It also adaptively assesses students' knowledge and confidence level around that knowledge and provide students with individualized instruction and additional practice questions as needed. Connect provides courses ranging from Accounting and Chemistry to Biology and Psychology, and instructors can customize Connect platform to give different range of assignments which the platform subsequently grades immediately and automatically. Connect platform also allows

instructors to upload recorded class lectures and presentations, highlight important sections of, and add notes to, the course e-book, as well as track student progress and concept comprehension (The McGraw Hill Companies, 2011).

In a report published by McGraw-Hill, the publisher of the Connect platform, student performance and satisfaction was reviewed in 18 case-studies of courses using the Connect platform. Data were aggregated from high enrollment general courses such as general chemistry, basic accounting, psychology, economics, biology, and marketing from diverse colleges and universities in the United States. The study reported four major areas of improvement. 1) Reduction in administrative time for instructors because of automated grading system provided by Connect 2) increase in effectiveness of lectures and engagement of students through Connect course materials that guides and prepare students before the class and be ready to be engaged in more meaningful and high level of learning 3) rise in student confidence and retention rates through adaptive learning techniques and access to recorded class lectures through Tegrity and 4) improvement in 3 to 5 points increase in test scores and overall grades (See Figure 2) (The McGraw Hill Companies, 2011).

In this study, we hope to see information retention rate of students through switching web-based platform to Connect. We will assess a significant change in information retention rate in students through utilizing adaptive learning techniques provided by Connect along with grades, attendance rate, and student retention rate.

Literature Review

Increasing student engagement through improving communication between students and instructor and among students through switching web-based platform

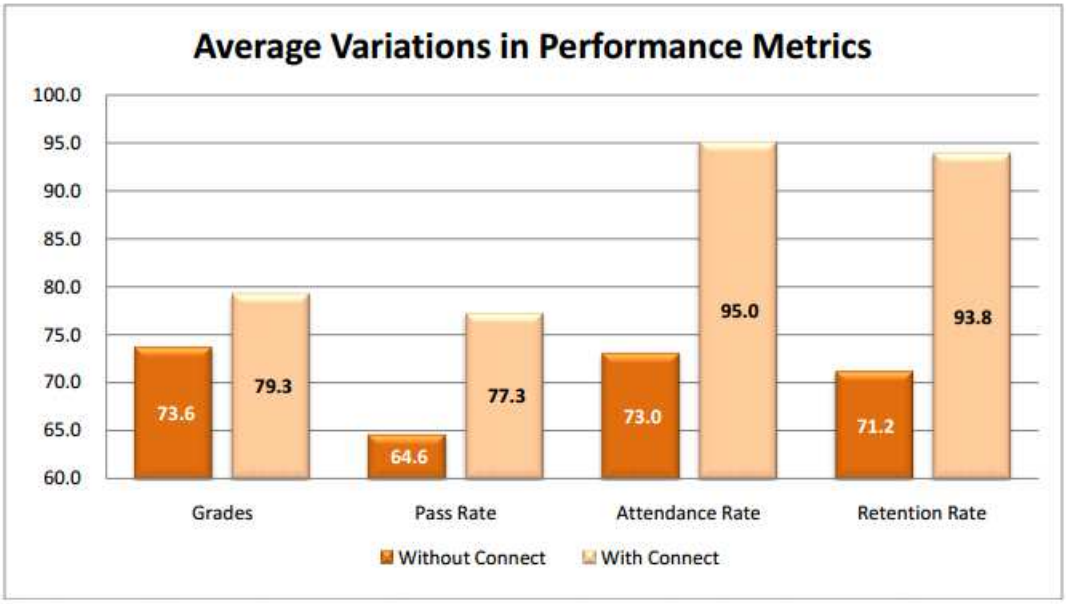

Figure 2: Average variations of "Without Connect" vs. "With Connect". Grades: based on 30 control/test groups, from 9 institutions of higher education, Pass Rates: based on 8 control/test groups from 5 institutions of higher education; Retention Rates: based on 6 control/test groups from 4 institutions of higher education; Attendance Rates: based on 2 control/test groups from 2 institutions of higher education (The McGraw Hill Companies, 2011).

and utilizing effective technology and a TA can be measured by various academic outcomes. Increased student pass rate, information retention rate, student satisfaction score for the class and stronger GPAs are used as indications of increased engagement in previous studies assessing the level of engagement of University students. (Banna et al., 2015, Carini et al., 2006; NSSE, 2014; Ward and Walker, 2008; Yadav et al., 2011). Overcoming the barriers, such as improving lack of interactions between students and instructors and among students, to increase various outcome listed above will result in creating better learning environments for students and will positively influence the learning behaviors of students (Bandura, 1986). Available evidence from peer-reviewed studies to identify a valid tool to measure student engagement and performance and to

assess barriers and solutions to achieve high levels of student engagement, performance, and satisfaction in college courses with an online learning component were reviewed. Information from the previous work in this area will inform the design of this study and decisions regarding the future design of the NDFS 1020 course.

Tools to assess student engagement

Course Engagement Questionnaire (SCEQ) was designed to measure student engagement, especially for lower division courses. To generate items, the study used inductive method by asking undergraduates and faculty at University of Colorado at Denver to describe what engaged students do, feel, and think. A preliminary questionnaire with 27 items was developed and it was asked to total 266 undergraduates (90 men, 175 women), ages ranged from 18 to 56 years in three disciplines, psychology, political science, and mathematics. Participants then completed few more questions such as “How engaged are you in this class?” and “How engaged are you in this class, compared to the other courses you’re taking this semester?” Participants were classified according to their answers. From the result, final 24 items were selected and determined into four dimensions of engagement (skills, emotional, participation/interaction, and performance). All four of the SCEQ factors were associated with at least one other measure; the different patterns among the variables supported the distinctiveness of the student engagement factors. (See Appendix 1) For example, performance engagement was associated mainly with traditional or extrinsic outcomes of achievement, such as assignment grades and midterm examinations. In comparison, emotional engagement was associated with intrinsic outcomes of learning, such as being engaged in the class and holding an incremental theory about learning (Handelsman et al., 2005).

Researchers then tested validity of the SCEQ on a different group of participants. Participants were 40 undergraduates (30 women, 10 men), ages ranged from 18 to 45 years, who were enrolled in a basic liberal arts mathematics class and who majored in a wide variety of subjects. Class grade, a commonly accepted proxy measure, for each participant were obtained and compared with the result of the questionnaire. As a result, the study found that the performance engagement was a significant predictor of homework assignment grades. Performance, participation/interaction and skills engagements were significant predictors of midterm grades. Participation/interaction engagement was a significant predictor of final exam grade. Thus, the study obtained evidence of convergent and discriminant validity of the SCEQ (Handelsman et al., 2005).

Also, the study obtained evidence for the reliability of the measure from empirical evidence; all the factors had reliabilities above the recommended level and showed the usefulness of the SCEQ. The study reported that the questionnaire gives an easily administered but comprehensive snapshot of students' engagement. It provides more information than simply asking students how they feel (skewed toward emotional engagement), watching their performance in class (skewed toward skills and participation/ interaction engagement), or making inferences according to their grades (skewed toward performance engagement) (Handelsman et al., 2005).

The National Survey of Student Engagement (NSSE) is a survey made by NSSE institute to measure the level of student participation at universities and colleges in Canada and United States yearly. The NSSE assesses "whether an institution's programs and practices are having the desired effect on students' activities, experiences, and outcomes" It organized engagement indicators into four engagement themes, which are:

level of academic challenge, active and collaborative learning with peers, experiences with faculty through student faculty interaction, and supportive campus environment (NSSE, 2014). However, the NSSE focuses on active learning and other educational experiences at the "macro level" and assesses students' overall perceptions rather than focusing on individual university courses. (Handelsman et al., 2005)

Factors That Influence Student Dropout Rate

One study looked at empirical research findings from 1999 to 2009 to review the factors that influence students' decision to drop out of a course. After identifying the factors, the study classified the factors into three main categories: (1) Student factors 55%, (2) course/program factors 20%, and (3) environmental factors 24%. Student factors such as lack of academic background and relevant experiences skills were recommended to implement strategies such as providing high quality and responsiveness of academic advising and ensuring that students are comfortable with technology and have good writing skills. Course/Program factors they identified related to course drop included poor course design and institutional support. The strategies for these factors included providing content, which is relevant to students' experiences and interests and utilizing tutors to support and identify at-risk students and provide them with appropriate guidance. Environment factors that affect dropout of a course were work commitment and poor supportive environment. As shown in Bandura's Social Cognitive Theory, the environmental factors are closely related to behavior of the students. Providing supportive environment for learners can lower the student dropout rates. There were no strategies the study found in the review for the work commitment but identifying students

as early as possible that might be more at-risk for excessive personal demands was mentioned (Banna et al., 2015).

False expectations of students' role in online and blended course also cause less engaged students and a high dropout rate. Students often do not realize that online and blended courses still require as much as a time commitment as the traditional classes. Students also often think that the online and blended courses will be easier than the traditional classes (Clay et al., 2009).

A case study to improve the communication and to increase the interactions between the instructor and the students in blended learning for Science, Technology, engineering and Mathematics (STEM). Live streaming of a lecture with online chat was used in different courses including Information Technology and Work-Integrated Learning at a university. Student surveys about their experiences in the live lectures and the weekly journals kept by teaching staffs were evaluated at the end of the semester. The result indicated that utilizing effective computer technology such as virtual chatting during the synchronized lecture, not only to on-campus students but also to off-campus students, gave the opportunity to take part in real-time and it allowed collaboration among both off-campus and on-campus students. However, implementing virtual chatting during the lecture requires a teaching staff to be diligent, flexible, spontaneous, cooperative, and inclusive at all times and will put a lot burden on the instructor (Hains-Wesson et al., 2015). When implementing this strategy, having a moderator, such as a TA, addition to the instructor will help to alleviate the burden of an instructor.

Published Web-Based Learning Platforms – Strengths and Weaknesses

There is growing number of web-based learning platforms available both for free and for sale as the demand for online and blended learning increase. While web-based learning platforms serve as a medium that allows greater flexibility of learning for students and various ways to deliver the contents for instructors, little is known of strengths and weaknesses of different platforms and under what setting they should be used.

There is a study reported that different web-based platforms can affect test performance of students. In the study, students completing an online quiz in one platform performed significantly better than another when the educational content in two platforms was identical. The study concluded that difference in the details of the user interfaces between two platforms affected the quiz scores (Tselios et al., 2001). Another study implemented a web-based platform to be used for blended language learning for adults. However, because of variety of technological difficulties, there was an outspoken negative evaluation towards the usability of the electronic platform (Hurkmans and Goos, 2013). A meta-analysis and review from U.S Department of education, after looked at different studies that used at web-based platforms, concluded that even though the alternative platforms can be used as primary delivery channels or as supplements to Web-based instruction, "overall, the controlled studies are too few to support even tentative conclusions concerning the learning effects of using alternative or multiple delivery platforms for online learning." (Means et al., 2009).

Student engagement is generally considered to be a better predicator of student's academic development. Engaged students has been found to be linked positively to

desirable learning outcomes such as critical thing and higher grades. Also, an institution that can engage its students is generally considered as a higher-level experience provider for its learners (Carini et al., 2006). The rationale behind this concept is self-explanatory. The more students practice or study, the most they tend to learn and the more feedback students get from their practice, the more adept they should become (Kuh, 2003).

The Link between Engagement and Information Retention and Student Learning

A study looked at the influence of study methods and long-term recall among 56 students from an anatomy class. There were many different study methods but the five most common study methods were detected. There were reading note/text book, memorization, recopying notes, groups study, and lab study. The study found that no single study method was related with academic success or long-term recall. However, students using a multitude of study methods of both passive (memorization, reading, recopying notes) and active study (group study, lab use) methods succeeded in the class and recalled more information when measured 1 year later. It was concluded that when students applied what they had learned in different contexts until it was understood and personally meaningful, the students had significantly better grade and recall (Ward and Walker, 2008). Another study assessed whether different formats (video, video + text, and text only) of delivering information influenced students' engagement and recall of cases of people diagnosed with HIV/AIDS. The study was done among 30 undergraduate students. Six weeks later, an interview was performed and students were asked to describe the individuals, their families, how the individuals were contracted HIV, and who were receiving medication. The resulted showed that video and text had similar cognitive effects as indicated by similar amount of recall of information but different

stories significantly influence students' evaluation, judgment, and recall. The study concluded that contents that are affective and emotional will have a better impact on learners' engagement and will lead to better recall (Yadav et al., 2011). These results suggest that by integrating multiple methods of teaching and making the contents in the teaching realistic, affective, and emotional can improve both students' engagement and recall of complex topics. A study used The National Survey of Student Engagement (NSSE) and RAND test to 1352 students at 14 four-year colleges and universities in 2002 (Carini et al., 2006). The four class levels were almost evenly represented (28, 25, 23, and 23% first year students through seniors respectively), 98% of participants were enrolled full time, about 57% were women, and about 73% classified themselves as exclusively White. The result was compared with their college-reported GPAs (Carini et al., 2006). RAND consist of a series of cognitive critical thinking problems including two essays prompts from the GRE. The study emphasized the importance of a constellation of institutional processes that may ‘‘add value’’ to student learning to increase student engagement. NSSE survey asked questions in scale such as frequency of student interactions with faculty, degree of participation in educationally fruitful activities to measure the enriching educational experiences, and degree to which the institution is perceived to be supportive to measure supportive campus climate. By comparing the survey and RAND and GPA, the study found that better RAND scores were reported by the institutions that were somewhat more effective at converting student-faculty interaction, enriching educational experiences, and supportive campus environment. Also the study found statistically significant positive relations between student engagement and GPA. However, the study concluded that the links between

student engagement and retention rate, student learning, and student satisfaction level are positively correlated but more researches are needed to investigate better tools for student engagement in the blended/online learning environment (Carini et al., 2006).

Another study looked at if a web-based learning platform can be used as a tool to integrate multiple methods of teaching in in high enrollment courses such as basic accounting and finance classes. There were total 287 students who participated in the study. After, a web-based learning platform, Connect by McGraw-Hill was implemented, the findings found the improvement of students' grades, specifically among the low performance students. When the grade distributions were compared between the before and the after the implementation of Connect, there were the same number of students who received grade A. However, 40% of the students received grade C+ to C-, 9% of the students received D+ to D-, and 0% of the students failed the course with Connect when only 29% of the students received grade C+ to C- and 11% of the students received D+ to D- and 6% of the students failed the course without Connect. The study suggested that having tools such as web-based learning which are flexible enough to fit into students' schedules definitely aid them to reinforce the knowledge receive during lectures thus improved course performance (Jaaman et al., 2013).

The Link between Engagement and Student Learning and Student Satisfaction

One study was done to answer whether students with a higher level of involvement (defined as a greater number of activities or spending more hours on one or more tasks) earn a higher cumulative GPA and/or perceive greater satisfaction with their overall educational experience. Using College Student Experiences Questionnaire from Indiana University Center for Postsecondary Research and NSSE, the study surveyed

over 21,000 students in 2009. Findings indicated that engaged students such as students who are spending more time on studying and having meaning conversation with faculty, staff, and peers, reported significantly higher satisfaction with their overall education experience. Also, students who perceived institutional emphasis on nonacademic support and interaction (participation in community service) were 2 to 3 times more likely to rate their overall satisfaction more positively. The study also found that seniors and full-time students spent more time on or completed a larger number of some academic tasks and reported greater satisfaction and academic success. Overall, the result indicated that higher levels of engagement such as building meaningful relationship with faculty and peers, working with classmates during and outside of the class, dedicating certain hours per week to prepare for class, and community service or volunteer work contribute not only to a higher cumulative GPA but also to perceived satisfaction with one's entire academic experience (Webber et al., 2013). As the study indicated, engaged students tend to spend more time preparing for the class and work actively with peers and participate in class activities. As a result, having more engaged students in the class will lead to students with higher GPAs and higher satisfaction level which are more likely to lead to higher class completion rate.

Conclusion

Studies above show that average levels of student engagement vary from one institution to the next and certain institutions more effectively convert student engagement into higher student performance (Carini et al., 2006; NSSE, 2014). Also, there are links between student engagement and information retention, learning and student satisfaction. The purpose of this study is to add value to student learning by

utilizing high impact tools to improve blended/online class environment to support positive change in students' behavior in learning and have positive outcomes such higher retention rate and higher performance score. The results will be compared with previous studies done in NDFS 1020 classes in Utah State University to confirm the improvement in student engagement and information retention rate, student learning and satisfaction.

Specific Aims and Hypothesis

Aim 1

To ascertain whether the use of a new online platform Connect will improve students' information retention rate, learning outcome and overall class satisfaction compared to the old online platform Mastering (Spring 2014) in an online/blended learning environment. Students' information retention rate will be measured with the same set of questions given in forms of pre-test (beginning of the semester), incorporated in final, and post-test (4 months after the semester ends). Students' learning outcome will be measured with quizzes, test scores, and final grades. The data for the overall class satisfaction will be collected through a student survey at the middle and at the end of the semester. It is predicted that the new method, Connect will result in higher students' information retention, performance and satisfaction than Mastering.

Aim 2

To determine whether purposeful novel strategies utilizing a graduate teaching assistant to increase student engagement in the blended and online sections of NDFS 1020 will improve students' retention, learning, and satisfaction. Apart from the traditional roles of the TAs, grading assignments and coursework, other strategies have been added. Strategies to increase student engagement include the use of technology such

as virtual chatting and web conference by a TA and various roles of a TA as a grader, a communicator, and a reviewer of students' performance to see if these implementations will effectively increase the students' academic engagement in an online/blended learning environment. We will hold weekly virtual TA sessions, debrief with an instructor, leaving thought provoking online comments when grading assignments if necessary, and conveying clear expectation of students in an online/blended learning environment. Surveys will be given to students at midterm and at the end of the semester to measure the engagement of students and class satisfaction. It is predicted that effective use of technology and a TA will allow more interactions between students and an instructor also among peers throughout the semester in the treatment group and it will increase the students' satisfaction, academic engagement and final grades compared to the control group.

Null Hypothesis

There will be no significant difference between control group and treatment group in satisfaction score and the final grade.

Study Rational and Significance

Even though blended learning exhibits a number of advantages over traditional lecture-based formats such as allowing instructional scaffolding through different online activities and allowing flexibility and student centered learning, blended learning models also pose some limitations. For example, blended learning models have been perceived as offering less interactions among students and between students and instructors compared to traditional learning environment. Also, there are too few studies that investigated various web-based platforms to draw a conclusion which kind of platform is to be use to

effectively increase the students' retention, learning, and satisfaction level (Means et al., 2009).

This study will incorporate existing tools such as using an alternative web-based platform, web conference, and utilization a TA, to enhance the blended learning. Through the information learned in the process of executing and completing the study, this research will be used to inform and improve the future design of NDSF 1020 course and other similar courses that are provided in universities.

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CHAPTER II

INCREASING STUDENT KNOWLEDGE RETENTION IN A GENERAL NUTRITION COURSE WITH A WEB-BASED LEARNING PLATFORM

Abstract

Web-based learning platform is a popular tool for instructors who are conscious of providing the most efficient learning environment possible for Millennials. In Utah State University, general nutrition course has been using Mastering as a web-based learning platform in a form of blended learning since Fall 2013. However, from a previous study, Mastering did not create the effect expected by course administrators and researchers. The aim of this study was to ascertain whether the use of a new online platform Connect improved students' information retention rate, exam scores and overall class satisfaction compared to the old online platform Mastering (Spring 2014) in an online/blended learning environment. Different from the prediction, the knowledge retention test scores were significantly increased in both Mastering and Connect groups and the average improvement of the knowledge test score was significantly greater in Mastering group. However, when below average and above average pre-test score groups were compared, the influence of using Mastering or Connect was not statistically different between the groups on students' knowledge retention rate at 4 months after the semester was over. Both Mastering and Connect helped students who have lack of fundamental knowledge in general nutrition when entering the course. However, the scores from comprehensive final exam and the student satisfaction level were higher in

Connect group. Thus, Connect has potential to increase the success rate of entry level students with greater class satisfaction in the general nutrition course than Mastering.

Introduction

There are rising enrollments of Millennials in universities, people born between 1980 and 2000. (Snyder and Dillow, 2016). Most aspects of primary and secondary education of this generation has been using technology as a learning tool. Because Millennials are accustomed to technology in learning, they also expect to use technology in higher education and the need of implementing more technology and prudent teaching pedagogy has risen. (Means et al., 2009). Instructors who are conscious of providing the most efficient learning environment possible for students are seeking for alternative teaching strategies to address the expectations and challenges of teaching to Millennials.

Limitations in the passive nature of traditional lecture-based methods of teaching has been discussed (Jennings, 2012; Teater, 2011). Various innovative educational theories and instructional methods have been developed in an attempt to increase the effectiveness of information transfer from instructor to student (Teater, 2011). When access to technology is increased in classrooms, it is thought to increase student's engagement by encouraging students to take initiative and responsibility for learning. As a result of using technology in the classroom, students were more motivated to learn, apply their knowledge to practical problems, and take ownership of their learning. Teachers also reported that, by using technology, students are developing important skills including creativity, collaboration and skills in problem-solving and critical thinking. Furthermore, by using technology, the learning experience becomes more meaningful for the student. Teachers have newfound time to see how to best instruct. They also have

more information to how their students are doing academically (Taylor and Parsons, 2011).

In high enrollment courses such as general nutrition web-based learning platform and e-textbooks are popular technology tools to replace the conventional teaching approaches. These web-based learning resources are touted by book publishers to produce a more meaningful learning experience. It enhances the students' knowledge retention thus improving students' academic performance (Jaaman et al., 2013). These resources are interactive and provide students with individualized instructions, thus improving their learning progress. Quizzes are graded instantly with real-time feedback. According to the result of the quiz, students get more or less practice questions.

Utah State University started blended learning as a way to bridge and maximize the advantage of both traditional teaching and the online teaching. Utah State University defines blended learning as a course that is taught both in-person/IVC and via Online. Participation is between 21 and 79 percent online with the remainder being in-person or IVC (Utah State University Center for Innovative Design & Instruction, n.d). The Science and Application of Human Nutrition (NDFS 1020), taught in a blended-design implemented a web-based learning platform in Fall 2013 and Spring 2014 in the hopes of improving student learning outcomes, including the retention of information. Mastering was introduced to the course in Fall 2013. It is a web-based learning platform published by Pearson Education. Mastering delivers a comprehensive teaching tool that reinforces concepts discussed in course readings, assignments, and lectures. Its' teaching tools include progressive questioning feature that helps students store and retrieve information more efficiently. Mastering also offers several different forms of questions and when the

student marks an incorrect answer, it tells the students where the information can be found in a text to increase active participation. SAs students reflect on their overall understanding of certain concepts, students understand how they learn and process information (metacognition) (Litchford, 2015).

However, Mastering did not create the effect expected by course administrators and researchers. The study reported that Mastering showed to be an ineffective tool in increasing overall letter grade of students during two consecutive semesters. Also, there were no differences in mean scores at pre, final, or posttests between control and treatment groups that were given to measure information retention rate. From their end of semester survey, the study reported that some students viewed Mastering assignments as busy work. They did not feel the assignments were contributing to their learning. The study concluded that the use of a web-based platform as part of the NDFS 1020 course structure should be re-evaluated and seems to be costing students more time and money than the benefit (Litchford, 2015). Also, another factor in our decision to switch was that Mastering didn't integrate fully with Canvas (Utah State University learning management program).

The instructors of NDFS 1020 sought for the other available textbooks, accompanying web-based learning platform. The Human Nutrition: Science for Healthy Living Text by Stephensen and Schiff and Connect platform by McGraw-Hill Education was reviewed and selected because it had similar learning objectives as NDFS 1020. Connect is a web-based assignment and assessment platform that uses digital technology and adaptive learning techniques to better connect professors to their students, and students to their course materials. SmartBook, Connect e-textbook, gave

adaptive “highlighted” reading that emphasizes critical content decided by the authors. As students read the highlighted content, questions were given to assess students’ knowledge and confidence level. Then SmartBook adopted and provided individualized instruction and additional practice questions as needed. Instructors can customize Connect platform to give different range of assignments which the platform subsequently grades immediately and automatically. Connect platform also allows instructors to upload recorded class lectures and presentations. Instructors can also highlight important sections and add notes to the course e-book, as well as track student progress and concept comprehension. The publisher of the Connect platform also reported reduction in administrative time for instructors, rise in student confidence and retention rates and improvement in 3 to 5 points. Also, there was an increase in test scores and overall grades from general courses such as general chemistry, basic accounting, psychology, economics, biology, and marketing (McGraw-Hill Connect® Effectiveness Study, 2011).

The aim of this study was to ascertain whether the use of a new online platform Connect improved students’ information retention rate, exam scores and overall class satisfaction compared to the old online platform Mastering (Spring 2014). The information learned in the process of executing and completing the study, will be used to inform and improve the future design of NDSF 1020 at Utah State and other universities.

Methods

The IRB (IRB Exempt - #7165) previously reviewed and approved of the study conducted in Fall of 2014 and Spring of 2016. Students were informed of the study during the first day of class with a consent form and a contact information for further questions.

Description of Population, Group Assignment, Grade Distribution

Participants were students enrolled in the introductory nutrition class, The Science and Application of Human Nutrition (NDFS 1020), at Utah State University (USU). Two blended sections (N=198) in Spring 2016 (Connect group) and a retrospective sample of students' data collected from (N=319) students enrolled NDFS 1020 course in Spring 2014 (Mastering group) were selected. Gender, ethnicity and age of the participants were assessed. There was difference in the score distribution on the exams and online assignments. The different score distribution by group is described in table 1. Students from the both group completed pre- and post-tests (knowledge retention test). In Mastering group, 314 students (98%) completed a pre-test and out of student who took the pre-test, 120 students (38%) completed a post-test. In Connect group, 196 students (99%) completed a pre-test and out of the students who took the pre-test, 58 students (30%) completed a post-test.

Description of Outcome Assessments

To assess the information retention rate through using web-based platform, a pre-test, the same set of questions incorporated in the final exam and a post-test were given to students in Mastering group and Connect group. The same set of questions were given to the students as a pre-test, in the final exam and as a post-test in Spring 2014 and as a pre-test in Spring 2016. For the final exam and a post-test in Spring 2016, questions were modified in order to use the same language that was used in SmartBook, the new e-textbook and in the lecture. However, the number of questions and the topics were the same. There were total of 10 multiple choices questions concerning basic nutrition concepts that were organized under objectives for NDFS 1020 course (See Appendix B,

Table 1. Score distribution by group

	NDFS 1020 SP 16 Points (%)	NDFS 1020 SP 14 Points (%)
Exams (3 Exams + Final)	110 pts * 4 = 440 (44%)	125 pts *4 = 500 (50%)
MDA Assignments (10 total)	20 pts * 10 = 200 (20%)	20 pts *10 = 200 (20%)
Practice Exams (4 total)	15 pts *4 = 60 (6%)	
Reading Quiz (14 total)		10 pts * 12 = 120 (12%)
LearnSmart assignments (220 pts total)	220 (22%)	
Mastery Benchmark (120 pts total)		120 pts (12%)
Live It Activities (6 total)	10 pts *6 = 60 (6%)	10 pts *6 = 60 (6%)
Additional assignments (2 total)	10 pts *2 = 20 (2%)	
Total Points	1000	1000

C and D). In Spring 2014, students who completed the pre-test were awarded ten extra credits in the course. Any student that chose not to take the survey were given other extra credit opportunities. In Spring 2016, pre-test was given as a regular class assessment at the beginning of the semester. The students' responses from the pre-test were collected via an online survey format through Canvas. 4-6 months after the end of the semester, to evaluate the information retention rate, emails with a link to complete the post-test were sent with a short letter via Qualtrics. (See Appendix E). As an incentive, participants were entered into a drawing with the potential to win prizes.

For Connect group, a mid-term evaluation was done to assess the student satisfaction during the semester, open questions were asked about their least favorite and most favorite aspects of the class. For both Mastering and Connect groups, exam scores, final exam, and final score of the class, and IDEA student course evaluations, the standardized course evaluation used by the institution was used as end of semester

assessments. IDEA course evaluations are on a 5 point scale with 1 being the most unfavorable response and 5 being the most favorable response.

Description of the Statistical Analyses

SPSS 22.0 (Statistical Package for the Social Sciences) was used to analyze the data. Functions including descriptive statistics, paired sample t-tests, two-way mixed ANOVA and three-way mixed ANOVA using a split variable, one-way ANOVA, two-way ANOVA and Chi squared were used to analyze the data collected.

Mixed ANOVA: within-subject factor was test (pre-test (1) and post-test (2)) and between-subjects factors were Mastering and Connect groups and pre-test score of Mastering and Connect, categorized into a below average group and an above average group.

The distributions of the exam 1, exam 2, exam 3, final exam, final score of the class, pre-test, and post-test were examined for normality. Normality was assessed using Q-Q plot and histogram for each design. Exam2, pre-test, post-test and the difference in pre and post-test were approximately normally distributed. Exam 1, exam 3, final exam, final score of the class were approximately normally distributed after data transformation. However, raw data were used in this analysis, except for exam 3, because the p-values from one-way ANOVA were not substantially affected by the transformation. Exam 3 was square rooted transformed (SQRT). Outliers were assessed by inspection of a boxplot and were retained in the dataset because they were believed to be genuine data points and the result was not substantially affected when outliers were included or excluded ($p > 0.05$).

Results

Descriptive Results

Descriptive statistics for study participants by group are provided in table 2. Previous study conducted data from Fall 2013 to Spring 2014 (Litchford, 2015). However, because of the low participants rate in Fall 2013, only the data from Spring 2014 (N=319) was used as a historical control (Mastering group). Compared to Mastering group, Connect group had significantly fewer female students. However, there were no significant difference in student characteristics on ethnicity (white or non-white) and the age range (18 – 24 age) between the groups.

Knowledge Retention Test

A paired-samples t-test was used to determine whether there was a statistically significant mean difference of pre- and post-test between the groups. (Table 3). A statistically significant increase in the score between the pre-test and the post-test was observed in both Mastering group and Connect group. ($P < 0.001$, $P = 0.006$ respectively). However, the increase was greater in the Mastering group (1.82 increase in Mastering group vs. 0.67 increase in Connect group). The increase was again confirmed by a repeated measures ANOVA which was conducted to assess the group by score over time effect between both Mastering group (Spring' 14) and Connect group (Spring' 16). Comparison between Mastering Spring' 14 and Connect Spring' 16 was significant, $p=0.005$, mean square=38.018, DF=1 (Figure 1) and estimated marginal means revealed that the change in the test score of Mastering group (Spring' 14) was significantly more than the change in the test score of Connect group (Spring' 16).

Table 2. Descriptive statistics for study participants by group

	Mastering (Spring' 14 n =319)	Connect (Spring' 16 n= 198)	P-value[1]
Female (%)	70	60	0.013
White (%)	87	89	0.563
18-24 years of age (%)	87	97	0.719
Pre-test[2] (n of students completed %)	5.26 (98%)	4.85 (98%)	0.01
Post-test[2] (n of students completed %)	7.07 (38%)	5.81 (30%)	< 0.001
Difference of Pre-,Post-tests[2]	1.82	0.67	0.006

[1]ANOVA and Chi-squared
[2]Averages of test responses, Range 1 – 10.

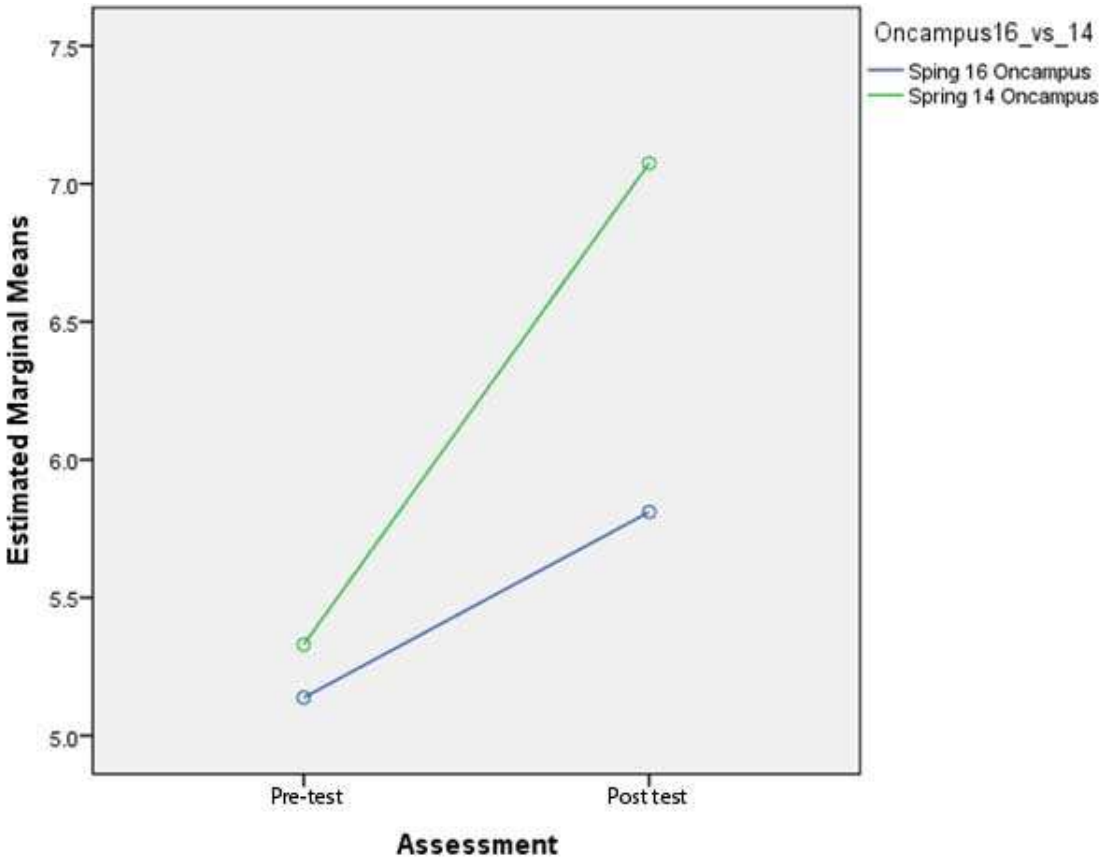
Two-way ANOVA was performed to see if characteristics of the students (gender, ethnicity) influenced the pre-test and post-test scores. Gender and ethnicity did not significantly influence the result of the scores. The pre-test score of Mastering group was higher than the Connect group (P=0.012 mean square=17.48, DF=1). Also, when the groups and either gender or ethnicity were factors, the pre-test was the dependent variable and Exam 1, exam 2, SQRT transformed exam 3, final exam and the final score of the class were covariates, Students in Mastering group earned a higher pre-test score than did students in Connect group (Gender: P=0.007, mean square=19.82, DF=1, Ethnicity: P=0.039, mean square=11.63, DF=1). There were no significant effect of gender and ethnicity and there were no interaction effects of group*gender and group *ethnicity.

The same was performed to see if characteristics of the students (gender, ethnicity) influenced the post-test scores. The groups and either gender or ethnicity were factors and the post-test was the dependent variable. Exam 1, exam 2, SQRT exam 3,

Table 3. Paired sample t-tests by group

	Pre-test (SD)	Post-test (SD)	p-value	Correlation coefficients	t- value
Mastering SP14 (n=120)	5.25(0.20)	7.07(0.22)	< 0.001	0.307	-8.06
Connect SP16 (n=58)	5.15(1.44)	5.81(1.58)	0.006	0.288	-2.83

Figure 1. Repeated measure ANOVA, Comparison of pre-test and post-test score between Mastering Spring' 14 and Connect Spring' 16



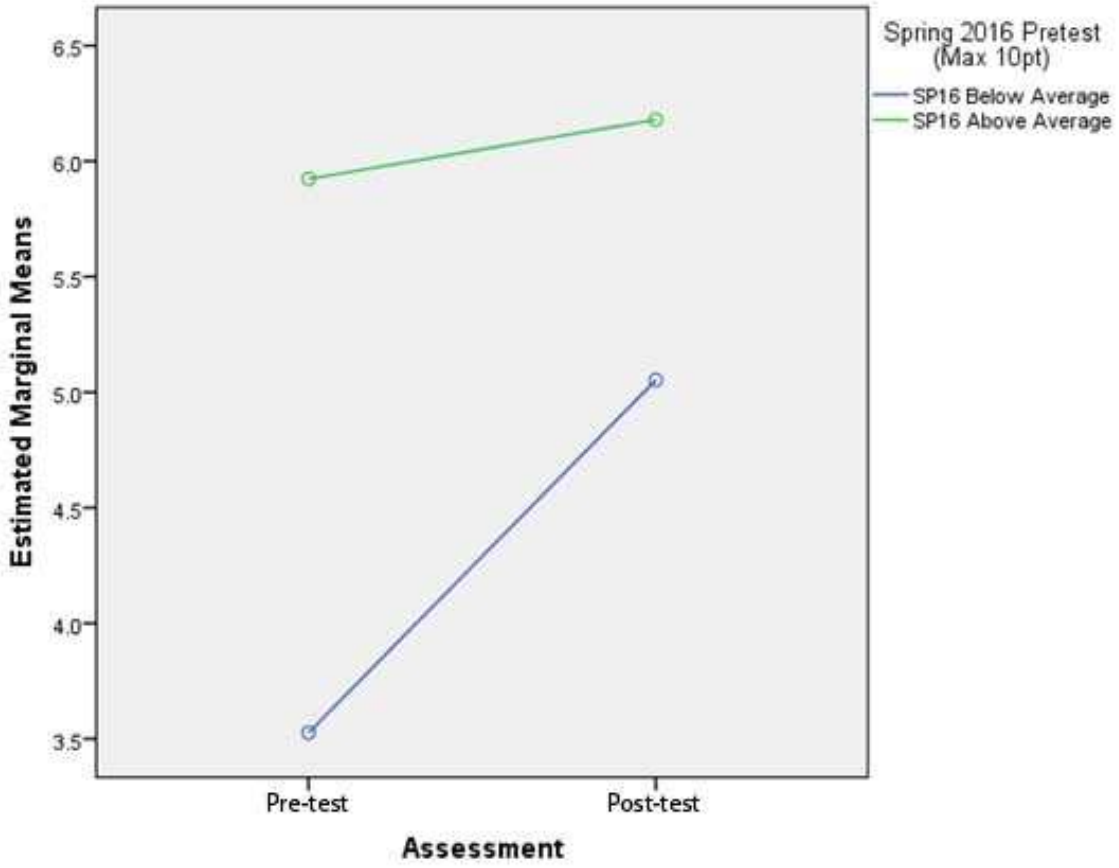
final exam and the final score of the class were included as covariates. Students in Mastering group earned a higher post-test score than did students in Connect group (P <0.001 mean square=127.0, DF=1). There were no significant effect of gender and ethnicity and there were no interaction effects of group*gender and group *ethnicity.

A two-way mixed ANOVA was conducted using a split variable to determine the effect of Connect in the student retention rate between the students who received below average (BA) pre-test score and the students who received above average (AA) pre-test score compared to Mastering. Participants were divided into two groups (above average, below average), depending on how they scored on the pretest.

The first two-way mixed ANOVA included only Connect group. There was a statistically significant interaction between the timing of the test (Pre-test, post-test) and BA and AA scores of pre-test, P=0.011, mean square=10.30, DF=1 (Figure 2). Simple main effects were run. Change in the test score was the dependent variable and the categorized (below average, above average) pre-test score of the Connect group was the fixed factor. In Connect group, students who received BA pre-test score had significantly greater post-test score (mean increase=1.53) and the students who received AA pre-test score (mean increase 0.26), P=0.011, mean square=10.30, DF=1.

The two-way mixed ANOVA was conducted again including only Mastering group. There was a statistically significant interaction between the timing of the test (Pre-test, post-test) and BA and AA scores of pre-test, P=0.002, mean square=31.53, DF=1 (Figure 3). Simple main effects were run. Change in the test score was the dependent variable and the categorized (below average, above average) pre-test score of the Mastering group was the fixed factor. In Connect group, students who received BA

Figure 2. Two-way mixed ANOVA for split variable, Comparison of change in the test scores in Connect (Spring' 16)



pre-test score had significantly greater post-test score (mean increase= 2.48) than the students who received above average pre-test score (mean increase 0.83), P=0.002, mean square=31.53, DF=1.

A three-way mixed ANOVA was run to understand the effects of groups, below average (BA) or above average (AA) pre-test scores, and timing of the knowledge retention test (Pretest vs. Posttest). The three-way interaction between the three effects listed above was not statistically significant, P = 0.624. Statistical significance of a

simple two-way interaction was accepted at a Bonferroni-adjusted alpha level of 0.025. There were no statistically significant simple two-way interactions between the groups and BA or AA pre-test scores at the beginning of the semester, P = 0.227 nor at the 4 months after the end of the semester, P = 0.936. There was a statistically significant simple main effect of BA or AA pre-test scores at the beginning of the semester and at the 4 months after the semester was over, P< 0.001, mean square=215.64, DF=1, and P= 0.002, mean square=39.80, DF=1, respectively. Also, there was a statistically significant simple main effect of Mastering or Connect groups at the begging of the semester or at the 4 month after the semester was over, P<0.001, mean square=18.53, DF=1, and P<0.001, mean square=75.72, DF=1, respectively. All pairwise comparisons were performed for statistically significant simple main effects. Bonferroni corrections were made with comparisons within each simple main effect considered a family of comparisons. Adjusted p-values are reported. Mean score for knowledge retention rate was higher in Mastering group in both pre-test and post-test, P< 0.001 (Table 3).

Exam Scores

A one-way ANOVA was done to compare the exam scores between Mastering and Connect groups. The test revealed that there were no differences between Mastering and Connect groups on exam 1 and 2. However, there were statistically significant differences in test scores among SQRT exam 3, final exam, and the final score of the class (P= 0.018, <0.001, 0.037, respectively) (Table 4). Descriptive statistics revealed that students in Connect group (Spring' 16) received higher exam scores for exam3 and the final exam and also earned higher final score of the class than the students in Mastering (Spring' 14) (Table 4 and Figure 4).

Figure 3. Two-way mixed ANOVA for split variable, Comparison of change in the test scores in Mastering (Spring' 14)

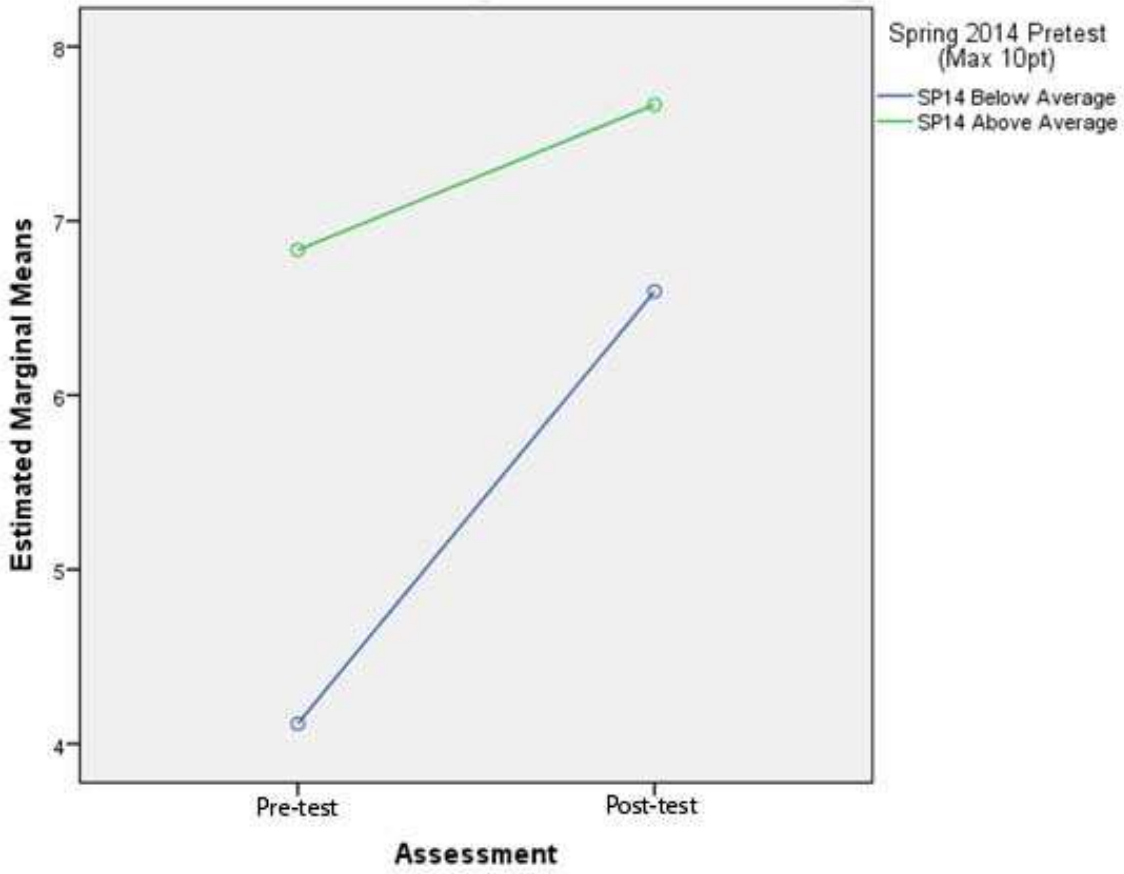


Table 4. One-way ANOVA comparing exam scores by group

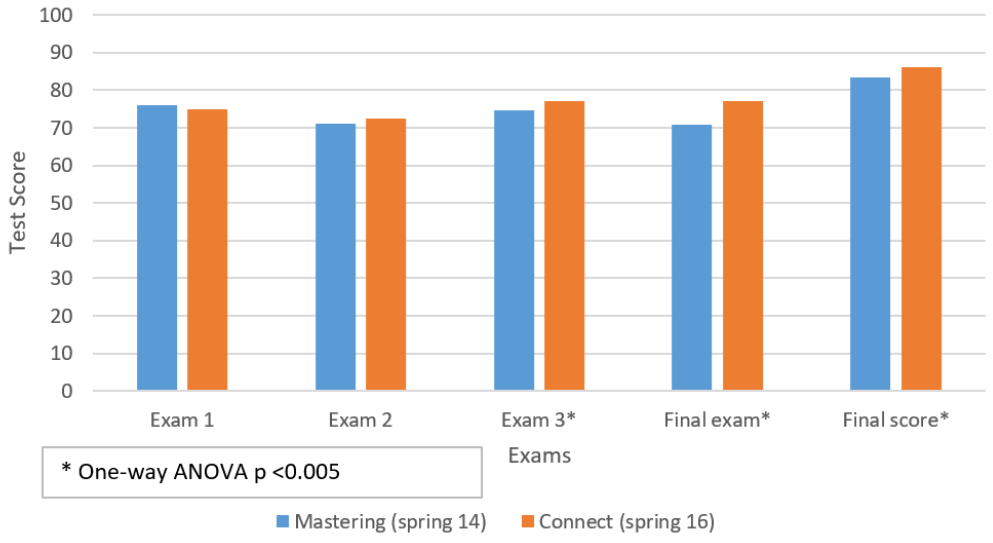
	Mastering SP 14 (SD)	Connect SP 16 (SD)	p-value	f-value
Exam 1	76.11 (16.36)	74.94 (21.31)	0.484	0.49
Exam 2	71.2 (13.8)	72.45 (20.1)	0.402	0.70
Exam 3	74.6 (15.56)	77.03 (20.05)	0.018	5.64
Final exam	70.84 (18.20)	77.19 (22.25)	<0.001	21.68
Final score	83.5 (12.69)	86.02 (14.20)	0.037	4.38

Student Satisfaction with Connect

Students were asked about the least liked and the most liked components of the class as a mid-semester evaluation in Connect group. In Connect group (N=170), 8 students (4.7%) complained about SmartBook practice questions that they feel like they like they are not getting anything, 2 students (1.2%) complained that McGraw-Hill website is too difficult to navigate. When asked about the favorite thing about the course, 14 students (8.2%) commented that adaptive "highlighted" reading feature of SmartBook helped with learning and 11 students (6.5%) mentioned about the real-time feedback and the interactive feature of SmartBook practice questions were enjoyable and helpful, and 2 students (1.2%) mentioned McGraw-Hill online resources were easy to access.

The raw IDEA scores for being an Excellent Teacher and an Excellent Course were higher in Spring of 2016 than they were in Spring of 2014 (4.3 vs. 3.8 and 4.1 vs. 3.7, respectively).

Figure 4: Exam score comparison between Mastering and Connect



Discussion

Summary of Main Conclusions

The knowledge retention test score was significantly increased in both Mastering and Connect groups at 4 months after the semester was over. Students in Mastering group earned significantly higher pre-test, post-test, and the change in the test scores and these scores were not mediated by characteristics (gender, ethnicity) of the students. However, between BA and AA groups, even though the average improvement of the knowledge test score was significantly greater in Mastering group, the influence of using Mastering or Connect was not statistically different between the groups on students' knowledge retention rate at 4 months after the semester was over. When the knowledge retention rate of Connect on the students who received below or above average pre-test score was assessed, the fining was consistent with the finding in the Mastering group. In both Connect and Mastering groups, students who received below average pre-test score earned significantly greater post-test score than the students who received above average pre-test score. When exam scores and the final score of the class were compared, students in Connect group earned significant higher scores in exam 3, final exam, and the final score of the class.

Interpretation and Context of the Results

Even though the students in Mastering group earned significantly higher pre-test, post-test, and the change in the test scores, the knowledge retention test score was significantly increased in both Mastering and Connect groups (1.82 increase in Mastering vs. 0.67 increase in Connect, $P < 0.05$). These scores were not mediated by characteristics (gender, ethnicity) of the students. In a report published by McGraw-Hill, the publisher of

the Connect platform, Connect helped to build student confidence in learning and greater content retention rate in 8 case studies. However, content retention rate was measured by the final score of the class at the end of the semester and the shift in the distribution of the final score was the evidence of the content retention rate. McGraw-Hill reported that with Connect, 60% of students receive as and Bs compared to the 43% from previous semesters that did not use Connect (McGraw-Hill Connect® Effectiveness Study, 2011). There is currently no research available that tests Connect exclusively and there were no other findings in current literature suggestive of relationship between web-based learning platform and knowledge retention rate after the semester was over.

According to our result, students who received below average pre-test score earned significantly greater post-test score than the students who received above average pre-test score. This finding is consistent with the result from Litchford (2015) the previous study from Spring 2014. The study reported that Mastering had a positive effect on the knowledge retention rate in the students that scored below average on course pre-test. Even though the average improvement was significantly greater in Mastering group, the influence of Mastering or Connect was not statistically different on students' knowledge retention rate. Thus, we concluded that Mastering or Connect both help in students' knowledge retention rate especially for the students with a low level of basic nutrition knowledge.

However, we found that students in Connect group earned significant higher scores in exam 3, final exam, and the final score of the class than the student in Mastering group. This result is consistent with the report by McGraw-Hill the courses that used Connect often produced a higher scoring students. McGraw-Hill reported that it is due to

reduce administration time of instructors because of Connect and instructors were able to focus on creating engaging lectures. The report also said that the real-time feedback from Connect better prepared students for higher level learning and increased learning outcomes (McGraw-Hill Connect® Effectiveness Study, 2011).

We assessed student satisfaction with Connect through mid-semester evaluation survey. When open questions were asked about the least favorite component and the most favorite component of the course, 5.9% of the students complained about using Connect as a web-based learning platform in the course and 15.9 % of the students commented that the features in Connect is enjoyable and helpful in learning. Litchford (2015) reported that the one of the reasons to re-evaluate the use of Mastering was because of low student satisfaction that it seems to be costing students more money and time than the benefit observe in the study group.

One study found that student course satisfaction level was positively related with student engagement and knowledge retention rate. It also reported that higher student engagement were linked with desirable learning outcomes as critical thinking and grades, and the lowest-ability students benefit more from the increased engagement, student learning (Carini et al., 2006). Another study reported that different web-based platforms can affect test performance of students even when the content was identical. The study found that difference in the details of the user interfaces between two platforms affected the quiz scores (Tselios et al., 2001). Hurkmans et al. (2013) also reported that variety of technological difficulties is one of the outspoken negative evaluation towards the usability of the web-based learning platform among adults.

Above finding are consistent with our finding. From our founding, it appears that student had higher level of satisfaction in using Connect compared to Mastering and several students commented that Connect was easy to navigate. We also saw that students in Connect group received higher final exam score, which was comprehensive and another indicator of a student knowledge retention rate, and higher final score of the class.

It was predicted that the new method, Connect will result in higher students' information retention, performance and satisfaction than Mastering. We found that the knowledge retention test score was significantly higher in Mastering group at four months after the semester was over. However, the comprehensive final exam scores, another indicator for the knowledge retention rate at the end of the semester, were significantly higher in Connect group. When students were divided into two groups, BA and AA pre-test scores, the influence of Mastering or Connect was not statistically different on students' knowledge retention rate at four months after the semester was over. Also, mid-evaluation course satisfaction survey and IDEA student survey score was higher in Connect group.

Rivera et al. (2002) looked for the relationship between student satisfaction level and the performance in using web based learning platform. The study stated that there were a number of problems with the course delivery platform and web materials, which it appears ultimately, affected the students' level of satisfaction with the web based course. However, surprisingly, overall student performance did not suffer and it appeared that student satisfaction rather than performance are the issues to be concerned about. The problems that affected student satisfaction level included, less flexibility of the platform

in allowing the instructor to tailor them to meet class requirements, lack of support for web delivered classes for both students and the instructor, and unclear and not specific specifications for the student's computer hardware, software, and telecommunications. Even though, there were student in both groups that were not satisfied with the platform that was used in the course, Connect resulted in higher level of student satisfaction and in higher score in the final exam and the final score of the class than Mastering. Through continuing evaluation of Connect, increasing student satisfaction level will help in providing meaning learning experience for the students in blended learning general nutrition course.

This study had several limitations. Because we used data collected from 2014, there were limited ways to gather information in student characteristics. Even though Connect also had wide range of students who are younger than 25 years old, because the way how student age was asked was different, (are you 18 – 25 years old vs. are you 18 - 24 years old), we could not include the age information in the analysis. Also, previous study from Litchford (2015) analyzed knowledge retention test scores at 3 different times, at the beginning of the semester, at the end of the semester and at 4 months after the semester was over. The test questions were incorporated into the final exam for the both groups. However, because of a technical problem, we were not able to extract the score of the knowledge retention test from the final exam in Connect group, ended up just comparing the score from the beginning of the semester to four months after the semester was over. This limited us from having greater understanding of students' knowledge retention rate at the end of the semester. Other limitations of the study include limited current literature on the effect of web-based learning platform, 30% response rate for the

post-test, and population bias. There were limited amount of studies about web-based learning platform and its effectiveness on knowledge retention rate. Only study we found on Connect and the knowledge retention rate was published by McGraw-Hill, and there may be a conflict of interest. We had 30% response rate for the post-test and there is a potential for nonresponse bias. Our suspected reasons for low response rate include, 4 months may be too long before a losing interest in the course the students took. Also, the survey was distributed through email, there is a possibility that the survey was automatically sorted as a spam or advertisement and the students did not even realize that it was a survey sent from us. Lastly, majority of the students in both groups were white, young (18 – 25 years old) and females. This creates a population bias in our sampling and our conclusion may not be the same for the general population with older students and male students.

There are strengths in this study. Except for the intervention, the characteristic of the participants, class objectives, and the score distribution of the class were similar between the historical control and the treatment group due to conducting the study at the same institute. Also, this study was able to find the positive effect of using Connect as a web-based learning platform in general nutrition class. Like Mastering, Connect was able to help students scored lower on the pre-test to gain more knowledge. Moreover, Smartbook, innovated tool used by Connect, seems to intrigue students to read and be better prepared for the class. However, the like Mastering, the benefit may not be as noticeable for students that already have fundamental nutrition knowledge when they enter the course (Litchford, 2015).

Summary

Different from our prediction, knowledge retention test score was significantly higher in Mastering group at four months after the semester was over. The knowledge retention test score was significantly increased in both Mastering and Connect groups at 4months after the semester was over. Like Mastering, Connect seems to help students who have lack of fundamental knowledge in general nutrition when entering the course. However, the scores from comprehensive final exam and the student satisfaction level were higher in Connect group. Connect has potential in increasing the success rate of entry level students with greater class satisfaction in the general nutrition course.

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CHAPTER III

INCREASING STUDENT ENGAGEMENT IN A GENERAL NUTRITION COURSE OFFERED AS AN ONLINE/BLENDED LECTURE VIA TECHNOLOGY AND USE OF A GRADUATE-LEVEL TEACHING ASSISTANT

Abstract

Universities are faced with rising enrollments of Millennials who have different expectations regarding traditional way of teaching and learning than did previous generations of students. Blended learning was introduced to maximize the advantage of both traditional teaching and the online teaching. However, to increase student engagement in blended learning, high quality support is required. The purpose of this study was to compare change in students' behavior in learning, outcomes such as increase in level of student satisfaction and higher performance score between blended on-campus control and treatment as well as blended on-campus treatment and online treatment when using high impact and readily accessible tools such as a teaching assistant and Google+. It was hypothesized that by adding additional opportunities for students to interact with instructors, TAs, and peers with increase student engagement with course material and will result in better student performance and satisfaction. We found that students in the enhanced on-campus section had higher final grades than did students in the on-campus control section. However, these scores were not mediated by baseline or change in student engagement during the semester. Baseline student engagement scores and change in student engagement score were associated with final grade, but there were no

differences in baseline or change in student engagement score by section. However, student attendance rate, another indicator for student engagement, was higher in the on-campus enhanced compared to on-campus control. More study is needed to find the best time to measure the change in student engagement during the semester rather than at the end of the semester.

Introduction

Universities are faced with rising enrollments of students who have different expectations regarding teaching and learning than did previous generations of students (Snyder and Dillow, 2016). Millennials, people born between 1980 and 2000, are accustomed to using technology to learn both in and outside of the classroom (Means etal., 2009). Integrating technology in teaching provides students with flexibility in learning that fits busy lifestyles of the students and allows for non-traditional teaching strategies that may be more effective than traditional face-to-face teaching (Utah State University Center for Innovative Design & Instruction, n.d).

Blended learning was introduced to the Utah State University campus as a way to bridge and maximize the advantage of both traditional teaching and the online teaching. Utah State University defines blended learning as a course that is taught both in-person/IVC and via Online. Participation is between 21% and 79% online with the remainder being in-person or IVC (Utah State University Center for Innovative Design & Instruction, n.d). In this study, outcomes such as student engagement score and final score of the class were analyzed by on-campus sections and by enhanced sections. On-campus sections are the blended control and blended treatment groups and enhanced sections are the blended treatment and online treatment group.

There are limitations to blended and online learning. Blended learning can be a viable model for both small and large previously traditionally formatted courses. In previous work, a blended format that included 50% of course time dedicated to online resources and 50% to traditional lecture based delivery was found to be more effective than the traditional lecture based format for a large general education nutrition course (The Science and Application of Human Nutrition). In the traditional large lecture-based course, student met for a 50 minute lecture three times per week. The course was taught in one large section of approximately 500 students. This format provided little opportunities for students to engage with the instructor or other students. When the blended format was introduced the course remained a 3 credit course, but students in the blended course meet for only 90 minutes per week in smaller sections of approximately 100 students. This provided students with additional opportunities to engage with the instructor and other students during class time, however, many students felt that there was less communication between instructor and students in the blended design. This was identified as one of the main limitation of the blended course ($p < 0.0001$) (Dimmick, 2013). Other studies have found that lack of interactions and the feelings of isolations are main attributors of a high dropout rate in online courses and this, low retention rates can lead to a loss of profits for institutions (Banna et al., 2015; Lee and Choi, 2011, Wang and Newlin, 2002).

Traditionally, in NDFS 1020, we observed a bit lower grades in online students than the on-campus students. However, from another study, it appears that there is no significant difference in student performance among traditional, full-time students, regardless of the class format (face to face, hybrid, online). (Rivera and Rice, 2002) and

the difference in lower grade may be due to difference characteristics of the students in NDFS 1020 online course (more part-time, older students). Eppler and Harju (1997) Found negative relationship between number of weekly hours working at a paid job and GPA. Nontraditional students (average age 29 years old, 26% part-time versus only 3% of traditional students) had significantly lower performance goal but significantly higher learning goal than traditional students. However, although learning goals were positively related with GPA, work commitment also played a role and work commitment countered the advantage of higher learning goal.

Successful blended learning requires high quality support at all levels including a well-organized course, instructors who are knowledgeable and comfortable with technology, and consistent support for students (Carr, 2014). Purposeful and meaningful strategies should be employed to facilitate and encourage consistent student engagement. The purpose of this study was to compare change in students' behavior in learning, outcomes such as increased level of student satisfaction and higher performance score between blended on-campus control and treatment as well as blended on-campus treatment and online treatment when using high impact and readily accessible tools such as a teaching assistant and Google+. We hypothesized that by adding additional opportunities for students to interact with instructors, TAs, and peers it will result in increased student engagement with course material and improved student performance and satisfaction.

Methods

The USU IRB (IRB Exempt - #7165) reviewed and approved the study and student participants provided a consent to participate. Students received a letter of

information delivered to them on the first day of class via Canvas, the Learning Management System used to deliver the course to students. The letter explained that their participation in the study was voluntary, that there was not consequence for them to not participant, and that they could decide to withdraw their participation at any time.

Description of Population

Participants of this study were students enrolled in the introductory nutrition class, The Science and Application of Human Nutrition (NDFS 1020), at Utah State University (USU) in Spring 2016 (N= 336). Two blended on-campus sections (n=197) of NDFS 1020 were selected to participate and were randomly assigned to either the either the treatment group or the control group. One online section (n= 139) of NDFS 1020 was also selected to compare the intervention outcomes between the blended on-campus and online courses.

Description of Group Assignment

The course was taught as usual in the on-campus control condition. Face to face lecture was held once a week for 90minutes; the other 1.5 credit hour worth of learning (50%) happened online at a time determined by the individual students. The role of the instructor was the same in both control and enhanced groups. The role of the instructor was to prepare and give a lecture once a week and manage the classes. The role of the TA was difference according to the section assignments. The TA performed the usual role of the TA in both sections. This role included grading weekly assignments and communicating with the students and instructor, usually by sending and responding to questions via email. The TA's role included additional responsibilities designed to encourage and support student engagement in the enhanced on-campus and on-line

sections. These additional responsibilities included the following. The TA left additional comments in assignments using the speed grader tool in Canvas when necessary, per week, average of 16 students for on-campus enhanced, 18 students for online enhanced. The TA made sure to address students by name in these comments. In these comments in assignments, TA referred students back to study materials if necessary, or/and explaining issue when students seem to be confused or misinformed. The TA was present and was available to answer questions through online virtual chatting during the scheduled synchronized lecture for both on-campus live lectures and on-line sections during the live-streaming lecture. The TA helped solve occasional technical problems during the lecture and answered additional questions from the student via virtual chatting. In addition, the TA held weekly debrief with an instructor to discuss common questions and concerns raised among students and the instructor addressed the issue at the next class session. To provide additional support to the highest risk students, the TA contacted students who did not take the syllabus quiz or received a grade of 70% or less on this assignment to make sure the student was aware of the expectations for the course and that the TA was available to provide technical or other assistance. In addition, the TA held weekly 30 minutes study and review session via web conferencing titled “crash meetup”. Students from both the online and on-campus sections were invited to attend. The “crash meetups” were broadcast via Google Hangout on Air and were held on a weekday evening to involve students who were not able to join the virtual chatting during the scheduled lectures that were held during the day. In these sessions the TA reviewed important concepts and the answered of the additional questions from the students to help

with upcoming exams and assignments. The TA also answered other nutrition related questions, outside of class materials, when asked.

The same instructor taught all sections of the course. One TA was assigned to both the on-campus and on-line enhanced sections of the course; however, the control on-campus section was assigned a different TA. TAs received standardized training and grading procedures before the course began.

Description of Outcome Assessments

336 students enrolled in either the on-campus blended (n=197) or fully online sections of NDFS 1020 (n=139) in Spring of 2016 consented to participate. All 336 students (100%) consented to participate in the study. During the first 2 weeks of the semester, students completed an online survey that included demographic information, self-reported perceptions of the healthiness of their diet and physical activity habits, and a modified version of the Student Course Engagement Questionnaire (mSCEQ). The Student Course Engagement Questionnaire (SCEQ) is a validated tool, developed by Handelsman et al. (2005) to assess student learning and motivation in traditional face-to-face lecture setting. The study reported evidence of convergent and discriminant validity of the SCEQ by relating SCEQ score with related constructs associated with student learning and motivation. The SCEQ includes 27-questions that measure four dimensions of student engagement namely skills, emotional, interaction, and performance. (Handelsman et al., 2005) One SCEQ question was modified and 8 questions were dropped to fit the different setting of the courses (traditional vs. blended/online) and left with only questions that are applicable to blended/online courses, see Appendix F and G. During the last week of the semester, students retook mSCEQ and was recorded.

Four weeks after the semester, the result of the syllabus quiz was reviewed by a TA and emails to the students who received seven out of ten or lower in blended enhanced and online enhanced sections. Email was sent to 2 students from online enhanced and all students from blended enhanced received eight or above. Through email, the TA asked if the students understood the expectation of the class and if the students have a computer access to finish assignments on time. Extra help was provided through email when a student needed help to navigate the web-based platform.

The number of people who came and participated in 30 minutes "crash meetup" web conference from each section was recorded weekly. The number of people who utilized the online virtual chatting during the class and number of people who joined synchronized class session for online treatment section were also recorded weekly. Range from one to four on-campus enhanced students and four to eight online enhanced students participated in weekly "crash meetup". Range from zero to two on-campus enhanced students and zero to three online enhanced students utilized the online virtual chatting during the class. Range from one to three online students joined synchronized class sessions each week, see Appendix H.

Student attendance of the class was randomly recorded throughout the semester. The attendance was recorded a total of 5 times in each on-campus control and on-campus enhanced sections. Students checked next to their names as the roll was passed around. As a mid-term evaluation, to assess the student satisfaction during the semester, open ended questions were asked about their least favorite and most favorite aspects of the class. The questions were asked through a survey tool in Canvas and the students were given 5 extra credits for completing the survey. End of semester assessments included

final score of the class, and IDEA student course evaluations, the standardized course evaluation survey used by the institution. IDEA course evaluations are on a 5 point scale with 1 being the most unfavorable response and 5 being the most favorable response.

Description of the Statistical Analyses

SPSS 22.0 (Statistical Package for the Social Sciences) was used to analyze the data. Functions including descriptive statistics, correlations, one-way ANOVA and two-way ANOVA were used to analyze the data collected. Fixed variables were either sections, on-campus control, on-campus enhanced and online enhanced sections or engagement scores, pre-student's engagement and difference in student engagement score. Comparisons were made between the on-campus control and on-campus enhanced sections as well as the on-campus enhanced and online enhanced sections.

The distributions of the difference in student engagement score, difference of student engagement survey score between in the beginning of the semester and at the end of the semester, and the final score were examined for normality. Residual analysis was performed to test for the assumptions of the two-way ANOVA. Normality was assessed using Shapiro-Wilk's normality test for each design. Outliers were assessed by inspection of a boxplot, and homogeneity of variances was assessed by Levene's test. The difference in student engagement score was approximately normally distributed ($p > 0.05$). The final score was also approximately normally distributed after log10 transformation ($p > 0.05$). There were 17 outliers from the difference in student engagement score and the final scores. Outliers were retained in the dataset because they were believed to be genuine data points and the result was not substantially affected when outliers were included or excluded. There was homogeneity of variances for both, difference in student

engagement score and transformed final score, ($p > 0.05$). A Pearson's product-moment correlation was run to assess the relationship between pre-engagement score and the final score and difference in engagement score and the final score in all three sections, on-campus control, on-campus enhanced, and online enhanced.

Pre-student engagement score and difference in student engagement score: When difference of engagement score and pre-student engagement score were used as independent variables, they were categorized into 3 groups, low 33%, middle 33%, and high 33%. Rank consisted of two levels (Freshman & Sophomore, Junior & Senior) to have more balanced sample size.

Results

Descriptive Results

Descriptive statistics of students by sections (on-campus control, on-campus enhanced, online enhanced) are provided in Table 1. There was no significant difference in student characteristics by section. 64% of students were female, 52% were freshman, <5% are dietetics or nutrition science majors, and 59% reported the present class to be their first experience taking a blended or fully online course. Compared to on-campus sections, online enhanced section had significantly fewer full time students, students who are 19 years and younger, and students who had never taken blended/online class previously. The on-campus sections had a significantly greater percentage of students who were 25 or younger (on-campus control 98% and on-campus enhanced 97%) than did the online enhanced (83% were 25 or younger). The online enhanced section had a significantly greater percentage of students who are older than 25 (17%) than did either of the on-campus sections. Also on-campus sections had a significantly greater

percentage of students (95% and 94%) who had little experience with online or blended courses than did the online enhanced section (80%). There were no differences in the baseline engagement score between on-campus control and on-campus enhanced group, or by on-campus enhanced and on-line enhanced sections, see Table 1.

Correlation among baseline engagement score, change in engagement score and final score were examined. The mean engagement score decreased from the baseline assessment to the end of semester in all sections. The mean change in engagement scores from beginning to the end of the semester was -5.76, -4.70, and -5.74 for the on-campus control, on-campus enhanced, and online enhanced sections, respectively (P=0.712). Baseline engagement scores and change in engagement score were correlated ($r = -0.235$; P=0.004); those with higher baseline engagement scores dropped less in engagement score at the end of the semester than did those with lower baseline engagement scores. In addition, both baseline engagement score and change in engagement score were correlated with final score earned in the course ($r=0.202$, $P<0.0001$; $r=0.23$, $P<0.0001$, respectively); regardless of the sections, students who were already engaged in the beginning of the semester and students who dropped less in engagement score at the end of the semester earned higher final score in the course.

Main Effect of Engagement Score

In a one-way ANOVA, there were no differences in change in engagement score by on-campus section ($P = 0.712$). Using a Chi-squared test, there were no differences in change in student engagement score by additional characteristics of the students including gender, experience taking blended or online courses, rank in school, healthiness of diet, or level of physical activity. However, change in engagement score was

influenced by ethnicity of the students. In a two-way ANOVA, where on-campus sections and ethnicity were factors and change in engagement score was the dependent variable, white students decreased their engagement scored from beginning to the end of the semester, and non-white students increased their engagement scores. (P =0.009, mean square=496.72, DF=1, F=6.91).

In a two-way ANOVA, where on-campus sections and categories of age were factors and change in engagement score was a dependent variable, age was not associated with change in engagement score. However, when a one-way ANOVA was done on the online enhanced only as a factor and change in student engagement score as the dependent variable, age was associated with change in engagement score among online students (P = 0.015 mean square=329.43, DF=2, F=4.35). LSD post hoc analysis revealed that older students, those 25 years of age or older, in the online enhanced section had less change in student engagement scores than did younger students (19 years and younger) in the online enhanced section (P =0.004); no similar age effect was observed among students in the on-campus section.

Final Score of the Class by On-Campus Control and Enhanced Sections

In a two-way ANOVA where section and tertiles of baseline engagement score were the factors and the log transformed final score was the dependent variable, students in the enhanced section earned a higher grade in the class than did students in the control section (P = 0.025, mean square=0.491, DF=1, F=5.10). In addition, students scoring in the lowest tertile of baseline engagement score earned a lower grade in the class than did students in the higher tertiles of engagement (P < 0.05 for post-hoc analysis of tertile 1 compared to tertile 2 and tertile 1 compared to tertile 3). There was no significant

Table 1. Characteristics of Students in NDFS 1020 SP '16 by Section

	On-campus Control	On-campus Enhanced	P-value	Online Enhanced	P-value
	N = 119	N = 78		N = 139	
Gender (Female %)	55%	66%	0.117*	65%	0.19*
Enrollment Status (Full time %)	97%	99%	0.353*	75%	0.0001*
Ethnicity (White %)	87%	92%	0.276*	92%	0.361*
Age Range			0.445*		0.0001*
<18 - 19 years old	49%	57%		33%	
20 - 25 years old	49%	40%		50%	
> 25 years old	2%	3%		17%	
# of Previously Taken Blended/Online courses			0.233*		0.0001*
None	67%	79%		39%	
Once or Twice	28%	15%		41%	
Three times and more	5%	6%		20%	
Rank			0.179*		0.063*
Freshman	66%	57%		46%	
Sophomore	25%	30%		36%	
Junior	7%	11%		15%	
Senor	2%	2%		3%	
Dietary Habits			0.105*		0.254*
Below Average	21%	15%		19%	
Average	50%	42%		51%	
Above Average	29%	43%		30%	
Physical Activity			0.166*		0.315*
Below Average	16%	20%		23%	
Average	33%	24%		28%	
Above Average	51%	56%		49%	
Baseline Engagement score	71.15 (8.339)	73.28 (8.467)	0.11†	72.64 (9.433)	0.205†

*P-values from Chi-Square

†P-values from F-statistics of Two Way Analysis of Variance

interaction between section and baseline engagement score (P = 0.432). In the same model that included terms for covariates of gender, age, ethnicity, rank, student status, and number of previous blended courses taken, healthiness of diet, physical activity level, the baseline engagement score continued to be associated with final scores (P<0.001, mean square=0.979, DF=2, F=10.61), but section was no longer significantly associated with final score (P = 0.063). Table 3 presents the estimated marginal means of final score by section in table 2 and estimated marginal means of final score by tertile of baseline engagement score. In a two-way ANOVA where section and tertile of change in engagement score were the factors and the log transformed final score was the dependent variable, neither section nor change in engagement score were significant (P= 0.087, 0.217, respectively). There was no significant interaction between section and tertile of baseline engagement score (P = 0.709).

Final Score of the Class by Enhanced On-Campus and Enhanced On-Line

In a two-way ANOVA where section and tertile of baseline engagement score

Table 2. Final score by tertile of baseline engagement score in on-campus sections

Table 2-1. On-Campus section using log 10 transformed final score class

Dependent Variable: Score_Final__log10

section	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
On-campus Control	1.106[a]	.029	1.048	1.164
On-campus Enhanced	1.019[a]	.035	.949	1.088

Table 2 Continued

Table 2-2. On-Campus section using raw final score of the class

Dependent Variable: Score_Final

section	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
On-campus Control	84.466[a]	1.288	81.924	87.008
On-campus Enhanced	89.285[a]	1.554	86.219	92.351

Table 3. Final score by section in on-campus sections

3-1. Baseline SE score using log 10 transformed final

Dependent Variable: Score_Final__log10_ref

Baseline SE score (Binned)	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low 33%	1.208[a]	.041	1.128	1.289
Middle 33%	1.046[a]	.039	.970	1.122
High 33%	.933[a]	.042	.849	1.016

3-2. Baseline SE score using raw final

Dependent Variable: Score_Final

Baseline SE score (Binned)	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low 33%	82.222[a]	1.787	78.697	85.747
Middle 33%	87.581[a]	1.690	84.246	90.916
High 33%	90.823[a]	1.853	87.167	94.479

were the factors and the log transformed final score is the dependent variable, students in the on-campus enhanced section earned a higher grade than did students in the online enhanced section (P=0.021, mean square=0.500, DF=1, F=5.49) In addition, students scoring in the lowest tertile of baseline engagement score earned a lower grade in the class than did students in the higher tertile of engagement (P=0.004, mean square=0.525, DF=2, F=5.69, $P < 0.05$ for post-hoc analysis of tertile 1 compared to tertile 3). Also, there was no significant interaction between section and tertile of baseline engagement score (P=0.289) In a model that included terms for covariates of gender, age, ethnicity, rank, student status, and number of previous blended courses taken, healthiness of diet, and physical activity level, the baseline engagement score and section continued to be associated with final score (P=0.010, mean square=0.616, DF=1, F=6.75, and P=0.008, mean square=0.447, DF=2, F=4.90, respectively). Table 5 presents the estimated marginal means of final score by section and table 4 and estimated marginal means of final score by tertile of baseline engagement score.

In a two-way ANOVA where section and tertile of change in engagement score are the factors and the log transformed score is the dependent variable, students scoring in lowest tertile of change in engagement score earned a lower grade in the class than did students in the higher tertile of change in engagement score (P = 0.040, mean square=0.232, DF=2, F=3.28, $P < 0.05$ for post-hoc analysis of tertile 1 compared to terile 2 and tertile 1 compared to tertile 3). However, section was not significantly associated with the final score (P= 0.132). There was no significant interaction between section and tertile of change in engagement score (P=0.604).

Student Attendance between On-Campus Control and On-Campus Enhanced

In a one-way ANOVA where section was the factor and the attendance points was the dependent variable, students in the on-campus enhanced came to the class significantly more than the students in the on-campus control (P=0.044, mean square=15.18, DF=1, F=4.10). Out of five days that are randomly recorded, the average days that students in on-campus control attended class was 2.46 and 3.02 in on-campus enhanced.

Table 4. Final score by tertile of baseline engagement score in enhanced sections

4-1. Enhanced sections using log 10 transformed final score of the class

Dependent Variable: Score_Final__log10

section	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Online Enhanced	1.109	.027	1.054	1.163
On-campus Enhanced	.982	.037	.909	1.056

4-2. Enhanced sections using raw final score of the class

Dependent Variable: Score_Final

section	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Online Enhanced	84.722	1.225	82.306	87.138
On-campus Enhanced	90.548	1.655	87.284	93.812

Student Course Evaluation

The raw IDEA scores for being an Excellent Teacher were the same between on-campus control and on-campus enhance but was higher in online enhance. (4.3 vs. 4.3 vs. 4.4, respectively) The score for being an Excellent Course were highest in online enhanced (4.3), second highest in on-campus enhanced (4.2) and lowest in on-campus control (4.0) The converted averages of these scores for on-campus enhanced and online enhanced were in the category of *higher* than those from all classes in the IDEA database in 2016. However, the converted averages of these scores for on-campus control were in the category of *similar* to those from all classes in the IDEA database in 2016.

Students were asked about the least liked component of the class in the mid-semester evaluation. In the on-campus control section (N=95), 12 students complained about meeting only once a week (12.6%), three students complained that the terminology in the class was too confusing (3.2%) and two students complained that there is no study group or sessions (2%) rest of the complaints were related to other class structures such as timed exams, hardness of the exam and the amount of weekly assignments. In on-campus enhanced section (N=73), only six students complained about meeting only once a week (8.2%) and other complaints were related to other class structures as listed above. When asked about the favorite aspect of the course, 11 students from on-campus enhanced (15%) commented on features included in the enhancements of the course including the interactions provided by the Google Hangout on Air broadcasts and crash-meet ups.

Table 5. Final score by section in enhanced sections

5-1. Baseline SE score by log 10 transformed final score of the class

Dependent Variable: Score_Final__log10_ref

Baseline SE score (33%Binned)	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low 33%	1.101[a]	.038	1.027	1.175
Middle 33%	1.092[a]	.038	1.018	1.166
High 33%	.944[a]	.040	.865	1.022

5-2. Baseline SE score by raw final score of the class

Dependent Variable: Score_Final

Baseline SE score (33%Binned)	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Low 33%	86.904[a]	1.681	83.589	90.219
Middle 33%	85.395[a]	1.686	82.070	88.721
High 33%	90.605[a]	1.780	87.096	94.115

Table 6. Final score and change in student engagement score by section

	On-campus Control	On-campus Enhanced	P-value*	Online Enhanced	P-value*
	N = 119	N = 78		N = 139	
Final Score	83.41 (16.516)	89.86 (8.615)	0.032	85.25 (15.515)	0.01
Log 10 transformed final score	1.13 (0.033)	1 (0.282)	0.005	1.1 (0.325)	0.107
Difference in Pre and Post Engagement Score (Range 19 - 95)	− 5.76 (8.511)	− 4.70 (8.764)	0.131	− 5.74 (8.968)	0.712

*P-values from F-statistics of Two Way ANOVA

Discussion

Summary of Main Conclusions

Students in the enhanced on-campus section had higher final grades than did students in the on-campus control section. However, these scores were not mediated by baseline or change in student engagement during the semester. Somewhat surprising to us was that the level of student engagement decreased over the semester. Baseline student engagement scores and change in student engagement score were associated with final grade, but there were no differences in baseline or change in student engagement score by section. However, student attendance was higher in the on-campus enhanced compared to on-campus control.

Students in the enhanced on-campus section had higher final grades than did students in the on-campus control section. Even though the both baseline engagement score and change in engagement score were positively correlated with final score earned in the course, there was no statistically significant baseline engagement score and change in engagement score differences between the on-campus sections. Somewhat surprising to us was that the level of student engagement decreased over the semester. Baseline student engagement scores, but not change in student engagement score, was associated with final grade, but there were no differences in baseline or change in student engagement score by section. However, student attendance was higher in the on-campus enhanced compared to on-campus control.

When all three sections were compared, there were no significant differences in student characteristics among the sections, except for the differences in students' status (fewer full time students in online), age (older in online) and number of times the

students took blended/online courses previously (higher in online). There was no association between section assignment and baseline engagement score, as listed in table 1. Higher the baseline student engagement score the students received, the higher motivation the students had to learn and progress in their education in the beginning of the semester. Regardless of the sections, students who were older than 25 years old or "white" students received higher baseline score than younger students or "non-white students". Wyatt (2011) also reported that the population of the students who are older than 25 years old is one of the largest and fastest growing population in higher education and this population has a greater sense of maturity, spends much more time on academics and subject matter and is highly focused, serious, and more motivated than younger and traditional students. This is consistent with our finding that older students may have more inherent interest to learn the course materials.

There has been a growing concern that certain groups of students (i.e., ethnic minority) may be at higher risk for low engagement in school. But previous studies found no difference in student engagement in different racial/ethnic groups. (Wang et at., 2011) However, the study found that African American students reported higher scores of emotional engagement (sense of connectedness to school) and are less likely to be behaviorally engaged (involvement and participation in learning and academic tasks) when compared to European American students. This is inconsistent from our finding and it may be due to the difference in measuring student engagement. Out of 19 questions of mSCEQ, only 6 questions were related to emotional and behavioral engagement. Also, due to a small number of students who were categorized as "non-white", more study is needed to understand the relationship between the baseline student engagement and the

ethnicity of the students. When student characteristics were compared between on-campus control and on-campus enhanced, there were no significant differences.

The mean engagement score decreased from the baseline assessment to the end of semester in all sections. When correlation among baseline engagement score, change in engagement score and final score were measured, those with higher baseline engagement scores dropped less in engagement score at the end of the semester than did those with lower baseline engagement scores (P=0.004). Our finding infers that student who came into the class with a high degree of interest in the subject matter were more likely to stay engaged and earned better grade in the class. However, there were no findings in current literature suggestive of relationship between baseline engagement and the change in engagement throughout the semester. In addition, both baseline engagement score and difference in engagement score were positively correlated with final score earned in the course (r = 0.202, P-value 0.0001; r = 0.23, P-value 0.0001, respectively). When comparing our results with the mSCEQ to the studies that also used SCEQ, the positive correlations between the baseline student engagement score and the final score and the change in engagement score and final score are consistent with the study from Handelsman et al. (2005). The study reported that SCEQ, especially performance engagement was associated mainly with extrinsic outcome such as assignment grades and exam grade. Another study that used SCEQ also had consistent finding, reporting the positive correlation between SCEQ average scores and the participation and performance in online self-quizzes (Büyükkurt et al., 2013).

Interpretation and Context of the Results

Our two outcome measurements were engagement score and final score of the class. There was no difference in change and engagement score may be due to the timing of when the measurement was taken. More investigation will be needed in the future to know the right timing to measure the change in student engagement score. However, in the enhanced sections, students were encouraged to stay engaged throughout the semester through difference interventions including an extra support of a TA and showed the less decrease of the engagement score compared to the on-campus control section.

Higher final score was earned by students in on-campus enhanced when compared with on-campus control section. Students in on-campus enhanced section also received statistically higher final score compared to online enhanced students. This shows that extra tools given to engage students in the enhanced sections were rightly used to have a better final score in on-campus sections. Baseline engagement score was still a good indicator of the students' final score and that may be due to the general fact that engaged students have already learned to discipline themselves so even when the interest of the class decreases, they were able to receive a higher final score in the class. However, even when the students had higher baseline engagement score in the control section, because of the lack of the extra academic support, the engagement did not necessarily lead to a better final score. This finding is consistent with a study from Person et al. that when structured curriculum and support services like tutoring was provided to first-year College students, positive outcomes such as higher GPAs were observed especially among at-risk students, students entering the institution with skills significantly below that of the average American middle school student.

At the end of the semester, white students had a decrease in engagement score where-as non-white students had an increase in engagement score independent from the influence of control or treatment group. However, we did not see a difference in the final score between the white and non-white students. Wang et al. (2011) also found difference in student engagement depended on student ethnicity, stated that European American students had lower scores on emotional engagement than African American students whereas European American students had higher scores on behavioral engagement than African American students. However, more investigation is needed in the future because of limited information we gathered about students' ethnicity at this time and due to a small number of students who were categorized as "non-white" and we can't detect differences among other ethnicities.

Among the findings between characteristics of the students and final score, we found that, in on-campus enhanced section, freshman students received higher finals score than a sophomore, junior, and senior student group. This was not true in the online treatment section and blended control section (section * rank p value = 0.011). The majority of students in the introductory nutrition course are freshman (blended control 66% and blended treatment 57%). Freshman students are often still in the process of figuring out how to navigate the course and study for the exam. It is believed that the interventions given to the on-campus enhanced section seems to help the freshman students to receive a higher final grade in the course. Unfortunately, we did not see this trend in online treatment section even though their averaged final score was higher than the blended control section. This may be due to the difference of the presence of a TA during the lecture and also due to different age distribution, significantly fewer younger

students in the online section. A TA was present through virtual chatting for the online enhanced students during the lectures. However, only few students were able to attend the synchronized online lecture and rest of the student watched recorded lectures without the presence of the TA, whereas the TA was able to be at the face-to-face lecture for the on-campus blended treatment students. Davies et al. (2005) also stated that greater online interaction did not lead to significantly higher performance for students achieving passing grades. More study is needed in the future to find suitable strategies for online students who are younger than 20 years old and/or freshman.

We saw a positive correlation between mSCEQ score and the final score of the class and this finding is consistent with Handelsman et al. (2005) that higher SCEQ score is associated with better class performance. However, different from our prediction, mSCEQ did not differ between control and enhanced sections. This can may be explained by the timing of the survey. We sent out the second set of mSCEQ survey at the end of the semester and by then, students may have lost motivation for learning and that may have resulted in inaccurate finding in change in student engagement. There was no current literature on when to measure the peak of student engagement through the semester. However, other factors may also be used to indicate level of course engagement. For example, class attendance rate was higher for on-campus enhanced compared to on-campus control. Also, from descriptive mid-semester evaluation result, we saw more students complaining about lack of guidance in on-campus control.

Lastly, one study reported that out-of-class contacts with faculty members appear to positively influence (though indirectly) student satisfaction (Kuh and Hu, 2001). This finding is consistent from our result. The same instructor taught the all courses in this

study. In on-campus sections, the raw IDEA scores for being an Excellent Teacher were the same between the on-campus control and on-campus enhanced. However, the score for being an Excellent course was higher in on-campus enhanced. Also, when the scores were categorized into standardized comparison category, enhanced sections, both on-campus and online, were in the category of *higher* than those from all classes in the IDEA database in 2016 when the score for on-campus control were in the category of *similar* to those from all classes in the IDEA database in 2016.

There were several limitations in this study. First, we may have missed the peak of engagement by measuring student engagement at the last week of the school. More study is needed to accurately measure the timing of students' peak engagement during the semester. It may give valuable insights in change in student engagement throughout the semester to the instructors. Second, there was no control for the on-line condition. Compared with on-campus courses, there are different challenges to be address in on-line courses. For example, the age distribution (e.g. greater number of older students) and the learning environment (e.g. working full-time as taking the course) may be different. Thus, the interventions worked for the on-campus students in this study may not work always for the on-line students. Lastly, majority of the participants in this groups were white, young (18 – 25 years old) and females. This creates a population bias in our sampling and our conclusion may not be the same for the general population with older students and male students.

One strength of the study was that we used a validated tool to measure student engagement. Previous studies reported that SCEQ can predict of academic performance and it consists with our finding that higher baseline student engagement score was

associated with higher final score of the class. However, to measure the change in student engagement throughout the semester, the timing of the post-engagement survey should be re-arranged for more reliable responses from the students. Other strengths of the study include comparisons of both on-campus and on-line classes; same instructor teaching the both control and condition classes; use of tools, such as a teaching assistant and Google+, that are free and readily accessible.

Summary

Students in the enhanced on-campus section had higher final grades than did students in the on-campus control section. However, these scores were not mediated by baseline or change in student engagement during the semester. Somewhat surprising to us was that the level of student engagement decreased over the semester. Baseline student engagement scores and change in student engagement score were associated with final grade, but there were no differences in baseline or change in student engagement score by section. This may be due to missing the timing to measure the peak of student engagement and more study will be needed to find the best time to measure the change in student engagement during the semester. However, student attendance rate can also be used as an indicator for student engagement and the attendance was higher in the on-campus enhanced compared to on-campus control.

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CHAPTER IV

IMPLICATION OF STUDY RESULTS CONCERNING WEB-BASED LEARNING PLATFORM AND INNOVATIVE USE OF A GRADUATE-LEVEL TEACHING ASSISTANT IN A GENERAL NUTRITION COURSE

Abstract

The effectiveness of a web-based learning platform, Connect, a teaching assistant and other readily accessible tools such as Google+ were assessed and evaluated in improving student engagement and academic outcome in blended general nutrition course. Evidence documented in previous studies have been evaluated. The tools that were used in this study were associated with higher final grade, improving student engagement and student satisfaction level and in increasing knowledge retention rate at the end of the semester. Also, it appears that Connect and the novel use of a TA helped at risk students such freshman and/or the students who have lack of fundamental knowledge in general nutrition. This study provided valuable insight into what strategies may work in large enrolled course taught in a blended format. More study is needed to identify the most effective teaching strategies for learning in teaching format that deliver some or all of the material in an online format.

Reflection

Use of Web-Based Learning Platform in General Nutrition Course

The results of our study concerning the web-based learning platforms, Mastering and Connect were not expected. When comparing between below average and above

average pre-test score groups, even though the average improvement of the knowledge test score was significantly greater in Mastering group, the influence of using Mastering or Connect was not statistically different between the groups on students' knowledge retention rate at 4 months after the semester was over. Evaluation of Mastering, published by Pearson Education, for NDFS 2010 was conducted in Spring 2014 at Utah State University. In the study, number of problems using Mastering were detected. Mastering failed to be an effective tool in increasing overall letter grade of the students. When the knowledge retention rate was tested, it showed no differences in mean scores between the control and treatment groups. Mastering did not integrate fully with Canvas (Utah State University learning management program), creating extra work for the instructor. Also, the students complained that the time spent in doing the assigned activates by Mastering could have been better spent to study the course material more productively if Mastering assignments were not required (Litchford, 2015). As an alternative solution, Connect, by McGraw-Hill Education was reviewed. SmartBook, Connect e-textbook, gave individualized support in learning such as adaptive “highlighted” reading and intrigued students to read and be better prepared for the class. The positive impact of Connect was reported by the study done by McGraw-Hill. The study provided evidence that Connect reduced administrative time for instructors, raised student confidence and knowledge retention rates, increased in overall grades from general courses such as general chemistry, basic accounting, psychology, economics, biology, and marketing (McGraw-Hill Connect® Effectiveness Study, 2011). The results of our study were consistent with McGraw-Hill’s reports of improvement in final exam score and overall grade when Connect was implemented in to the course, compared to Mastering.

The average improvement of the knowledge test score was significantly greater in Mastering group. However, when below average and above average pre-test score groups were compared, the influence of using Mastering or Connect was not statistically different between the groups on students' knowledge retention rate at 4 months after the semester was over.

Other evidence that suggested positive effects of Connect was noticed. Like Mastering, Connect also showed evidence that it helped to gain basic nutrition concepts over the duration of the course for the students who have lack of fundamental knowledge in general nutrition when entering the course. From the mid-semester evaluation, our study found that 16% of the students commented that the assigned activities by Connect were their favorite part of the course. At the end of the semester, IDEA course evaluations revealed that students showed higher satisfaction level in Connect compared to Mastering (4.3 vs. 3.7, respectively).

In using web based learning platform, the student satisfaction level impacts the academic performance outcome. (Rivera and Rice, 2002). With some evidence from our study, Connect showed to be an effective tool in improving academic outcome and student satisfaction in a general college level class. The information learned in the process of executing and completing the study, can be used to inform and improve the future design introductory level college courses in universities, including Utah State University.

Novel Use of a Teaching Assistant in General Nutrition Course

In blended introductory nutrition course, addition to the regular interaction between students and an instructor, we added virtual opportunities for the students to

interact with TAs, and peers. It was to increase student engagement with course material and to improve student performance and satisfaction. When additional interactions were added, we saw improvement in final grade in the course, student attendance rate, and course satisfaction level.

Successful blended learning requires high quality support at all levels including a well-organized course, instructors who are knowledgeable and comfortable with technology, and consistent support for students (Carr, 2014). In this study, additional resources such as weekly virtual TA review sessions using Google+ and presence of the TA to help solve occasional technical problems during the lecture, were provided. The TA also answered additional questions from the student via virtual chatting during the class. To measure the successfulness in this course, student engagement score and final score of the class were used.

Student Course Engagement Questionnaire (SCEQ) was used in this study to assess student learning and motivation. (Handelsman et al., 2005) However, to be used in the blended learning setting, the questionnaire was modified (mSCEQ). During the semester, mSCEQ was given to the students twice, in the beginning of the semester and at the end of the semester, to measure the change in the engagement level among the students. We found that students in the treatment section had higher final grade than did students in the control section. We also found the baseline engagement and the change in the engagement score were associated with the final grade in the class. However, surprisingly, the final grade was not mediated by the baseline engagement score or the change in student engagement score. It can may be explained by the timing of the second survey. The engagement score dropped for both control and the treatment sections at the

end of the semester and we may have missed the survey timing to measure students' peak engagement level. If we have known the right timing to measure the peak engagement level, we could have accurately assessed the relationship between the change in the student engagement level and the final score of the class.

Without the evidence that our interventions increased students' engagement score during the semester, it is difficult to conclude that the novel use of a TA improved student engagement. However, other factors, such class attendance rate, and the course satisfaction survey result may also be used to indicate the level of course engagement. Class attendance rate was higher for the treatment section compared to the control section. From descriptive mid-semester evaluation result, we saw more students complaining about lack of guidance in the control section. Also, students in the treatment section gave a higher mean score for being an Excellent course at the end of the semester IDEA survey, the standardized course evaluation survey used by the institution.

Baseline engagement score, measure by mSCEQ, was still a good indicator of the students' final score. Students with higher level of initial engagement were able to receive a higher final score in the class even when the interest of the class decreased. This may be due to the fact that they have already learned to discipline themselves. However, we saw that in the control section, even when the students had higher baseline engagement score, because of the lack of the extra academic support, the engagement did not necessarily lead to a better final score.

Final score in the course was higher in the treatment section compared to the control section. This shows that extra tools given to engage students in the treatment section were rightly used to have a better final score. We also found that freshman

students in blended course treatment section received higher finals score than a sophomore, junior, and senior student group but it was not true in the control section.

We also observed the change in students' behavior in learning, and other outcomes that were listed above in online treatment section. Even though the final score of the class was higher than the on-campus control section, it was not statistically significant. The engagement scores also dropped at the end of the semester. However, we saw a higher IDEA rating for an Excellent Course than the on-campus control section.

To assess the feasibility of the interventions that were used in this study, TA time card was recorded. For on-campus treatment section (N=78), 1.5 hr. to 2.5 hr. per week was used in grading. 0.5 hr. to 1 hr. per week was used in answering questions from the students via emails and 1 hr. to 1.5 hr. per week was used in preparing for the weekly review sessions. Weekly, the TA held 30 minutes review sessions, attended class (1.25hr.) and spent less than 15 minutes to discuss common questions among the students with the instructor. In total, besides grading, the TA spent 3.5 hr. to 4.5 hr. per week in supporting students and we concluded that using a TA as an extra academic support is a feasible tool.

Our study found some evidence that the extra academic support through using technology and a TA have positive impact on the student engagement level and the final grade in blended general nutrition course. The information learned in this study can be used to better understand the relationship between the student engagement and the learning outcome in general college courses especially in blended learning. More study is needed to find the best time to measure the change in student engagement during the semester to accurately measure the effectiveness of the interventions in increasing student

engagement. Also, more study is needed in the future to find suitable strategies to increase student engagement for online students in general college course.

Summary

We found some evidence that Connect and other high impact and readily accessible tools such as a teaching assistant and Google+ showed to be effective tools in improving academic outcome and student satisfaction level in a blended general college level class. It appears that Connect and the novel use of a TA helped at risk students such freshman and/or the students who have lack of fundamental knowledge in general nutrition, to be more successful in the introductory nutrition course. This study provided valuable insight into what strategies may work in blended learning. More study is needed to also find suitable teaching strategies for online students in general college course.

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APPENDICES

Appendix A. Factor Structure of Student Course Engagement Questionnaire				
Items	**Skills**	**Emotional**	**Part/Int***	**Performance**
Making sure to study on a regular basis	X			
Putting forth effort	X			
Doing all the homework problems	X			
Staying up on the readings	X			
Looking over class notes between classes to make sure I understand the material	X			
Being organized	X			
Taking good notes in class	X			
Listening carefully in class	X			
Coming to class every day	X			
Finding ways to make the course material relevant to my life	X	X		
Applying course material to my life		X		
Finding ways to make the course interesting to me		X		
Thinking about the course between class meetings		X	X	
Really desiring to learn the material		X	X	
Raising my hand in class			X	
Asking questions when I don't understand the instructor			X	X
Having fun in class			X	X
Participating actively in small group discussions			X	X
Going to the professor's office hours to review assignments or tests or to ask questions			X	X

Appendix A. Continued				
Helping fellow students			X	X
Getting a good grade				X
Doing well on the tests				X
Being confident that I can learn and do well in the class				X

*Part/Int =Participation/Interaction

Appendix B. Pre-test and post-test questions

Pre-Test Quiz Questions

1. Research findings and results that are _____ are the most reliable.

A. Reported in a newspaper

B. Talked about at a community gathering

C. Published in a peer-reviewed journal

D. Addressed on CNN or another news station

E. I have no idea

2. Adequate fluid consumption, carbohydrate counting, restricted intake of simple sugars, daily glucose testing, and weight management are all recommended measures for

A. Preventing Diabetes

B. Treating Diabetes

C. Preventing Cancer

D. Treating Heart Disease

E. I have no idea

3. You are trying to decide what kind of soup to have for dinner. You have discovered that your diet is often low in iron (a mineral that's required for proper oxygen transport in the body). Which of the following soups would give you the most iron per kcal? Bean Soup = 3.08 mg Iron (191 kcals) Chicken Noodle = 1.34 mg Iron (117 kcals) Tomato Soup = 1.81 mg Iron (161 kcals) Vegetable Soup = 2.45 mg Iron (96 kcals)

A. Bean Soup

B. Chicken Noodle

C. Tomato Soup

D. Vegetable Soup

E. I have no idea

4. Once absorbed, all monosaccharides are converted to _____ by the liver.

A. Glucose

B. Fructose

C. Galactose

D. I have no idea

5. Which of the following represent a significant source of vitamin E in the diet?

A. Green Leafy Vegetables

B. Meat and Poultry

C. Milk and Cheese

D. Nuts and Seeds

E. I have no idea

6. In general, B vitamins function as _____ and are needed for metabolism and energy production.

A. Coenzymes

B. Enzymes

C. Oxidants

D. Metabolites

E. I have no idea

7. The following nutrients are listed in this order on a food label: enriched wheat flour (flour, niacin, reduced iron, thiamine mononitrate, riboflavin, folic acid), vegetable shortening, salt, sodium bicarbonate, malted barley flour, yeast. What can you conclude?

A. This product is high in protein

B. This product is organic

C. This product has no trans-fat

D. This product is a source of folic acid

E. I have no idea

8. Compared to food that's been transported, locally grown foods

A. Are always more expensive

B. Are often more flavorful and fresh

C. Require more labor and effort to grow

D. Must be packaged in a certain way

E. I have no idea

9. Which of the following statements concerning weight management and fitness is NOT true?

A. Weight changes are influenced more by meal composition (% CHO, Fat, Protein) than kcal content

B. Spot reducing is a myth -- You can tone muscles but cannot target fat loss from certain areas

C. Experts recommend 10,000 steps per day (~5 miles) to improve health & reduce risk of disease

D. Modest weight loss (5 - 10%) can improve health outcomes and decrease disease risk significantly

E. I have no idea

10. Which of the following is NOT a recommendation for healthy weight loss?

A. Skipping meals regularly to decrease energy intake

B. Reduce energy intake & increase energy expenditure

C. Keep a record of your food and activity habits

D. Be aware of portion sizes and satiety cues

E. I have no idea

Appendix C. Post-test questions, Modified

Research

1. Which of the following is the most credible source of information in the field of nutrition?

A. Popular press magazines such as Cooking Light, Men's Health, or Prevention Magazine.
B. CNN or another news outlet.
C. Peer-reviewed journals that report original research in the field, such as the Journal of the Academy of Nutrition and Dietetics.
D. Your doctor, or other doctors that give information on TV shows or the Internet.

Risk factors for diabetes

2. Which of the following is the most important risk factor for the development of type II diabetes?

A. Having a family member with type II diabetes
B. Eating simple sugars
C. Not being physically active
D. Being overweight or obese

Nutrient density

3. Which of the following foods is the most nutrient dense choice of a snack that provides calcium, vitamin D, and protein?

A. 1 cup of chocolate ice cream
B. 1 cup of chocolate milk
C. 1 cup of cooked spinach
D. 1 cup of yogurt, made from low fat milk and no added sugars
E. All of these foods have about the same nutrient density for the nutrients listed

Carbohydrates

4. Which of the following carbohydrates is absorbed from the GI tract into the blood in the small intestine?

A. Starch
B. Lactose
C. Sucrose
D. Fructose
E. All of the carbohydrates listed above are absorbed from the GI tract into the blood.

Vitamin function

5. Which of the following is a TRUE statement about the group of vitamins known as B-vitamins?

A. The B-vitamins are fat soluble vitamins and require the release of adequate amounts of bile for their absorption.
B. The B-vitamins main function in the body is to support bone mineralization.
C. It is difficult to get enough B-vitamins from food sources alone. Almost everyone could benefit from dietary supplements of B-vitamins.
D. Mainly function as co-enzymes for enzymes that support energy production in the body.

Minerals

6. Which of the following is a significant food source of the mineral potassium?
A. Fresh fruits and vegetables
B. Red meat
C. Whole grains
D. Dark meat fish, like sardines

Labels

7. The Nutrition Facts panel of a food lists the following information: The food provides 80 kcalories in one serving including 4 grams of fat (0 grams of trans fat, 1.5 grams saturated fat) and 11 grams of carbohydrate (1 grams of fiber, 6 grams of sugar) and 1 gram of protein. Ingredients: whole grain rolled oats, honey, partially hydrogenated soybean oil, rice flour, high maltose corn syrup, cocoa, baking soda. What can you conclude from this information?
A. This product contains no added sugar.
B. This product contains no trans-fat.
C. This product contains trans-fat.
D. This product contains no genetically modified ingredients.

Sustainability

8. Which of the following dietary patterns best supports sustainable agriculture?
Eating a mostly plant based diet of mostly locally produced foods. This diet includes a lot of variety because food selections are determined by what is in season at different times during the year.
Eating a low carbohydrate, high protein diet that includes at least one animal protein source per meal. Most foods are purchased at a local grocery store.
Eating only organically produced and GMO free foods including a good variety of both plant and animal sources.
Eating only gluten free foods.

Risk of obesity

9. Which of the following is the strongest risk factor for an individual becoming overweight or obese in their lifetime?
A. Having a biological parent who is obese.
B. Having lactose intolerance.
C. Being married.
D. Eating animal foods several times per day.

Healthy Weight Loss

10. Which of the following is NOT a recommendation for healthy weight loss?
A. Skip meals regularly to decrease energy intake.
B. Reduce energy intake and increase energy expenditure.
C. Keep a record of your food and activity habits.
D. Be aware of portion sizes and satiety cues.

Appendix D. Learning objectives used to categories questions used for pre, final, and posttest. Actual questions used for testing are organized under specific objectives.

IDEA objective 1a: Gain FACTUAL KNOWLEDGE (terminology, classifications, methods, trends). Describe the digestion and metabolism of the energy nutrients (carbohydrates, lipids, protein).

- Once absorbed, all monosaccharides are converted to _____ by the liver.
- In general, B vitamins function as _____ and are needed for metabolism and energy production.

IDEA objective 1b: Gain FACTUAL KNOWLEDGE (terminology, classifications, methods, trends). Identify the nutrients needed to maintain health and body function. Be familiar with symptoms of nutrient deficiencies and toxicities. Recognize food sources for each nutrient.

- Which of the following represent a significant source of vitamin E in the diet?
- Adequate fluid consumption, carbohydrate counting, restricted intake of simple sugars, daily glucose testing, and weight management are all recommended measures for

IDEA objective 2a: Learn FUNDAMENTAL PRINCIPLES, generalizations, or theories. Discuss the role of nutrition in relation to health and the prevention of chronic disease.

- Which of the following statements concerning weight management and fitness is FALSE?
- Which of the following is NOT a recommendation for healthy weight loss?

IDEA objective 3a: Learn to APPLY COURSE MATERIAL (to improve thinking, problem solving, and decision-making). Describe what constitutes a sustainable food system and understand the effects of food policy and production on consumers.

- Compared to food that's been transported, locally grown foods _____.

IDEA objective 3 c: Learn to APPLY COURSE MATERIAL (to improve thinking, problem solving, and decision-making). Evaluate food quality based on food labeling, nutrition labeling, and food safety practices.

- You are trying to decide what kind of soup to have for dinner. You have discovered that your diet is often low in iron (a mineral that's required for proper oxygen transport in the body). Which of the following soups would give you the most iron per kcal? Bean Soup = 3.08 mg Iron (191 kcals) Chicken Noodle = 1.34 mg Iron (117 kcals) Tomato Soup = 1.81 mg Iron (161 kcals) Vegetable Soup = 2.45 mg Iron (96 kcals)
- The following nutrients are listed in this order on a food label: enriched wheat flour (flour, niacin, reduced iron, thiamine mononitrate, riboflavin, folic acid), partially hydrogenated vegetable shortening, salt, sodium bicarbonate, malted barley flour, yeast. What can you conclude?

IDEA objective 11b: Learn to ANALYZE & CRITICALLY EVALUATE ideas, arguments, and points of view. Differentiate between credible, science-based sources of nutrition information and unreliable sources.

- Research findings and results that are _____ are the most reliable.

Appendix E. Sample Post-Test Email

Students,

This is a reminder to complete the quiz for NDFS 1020 and enter one of two $100 Best Buy Gift Cards! The deadline for participation is Thursday September 1st so don't delay.

You have been selected to participate in a research study that focuses on nutrition education. This email is being sent to you because you completed NDFS 1020 (The Science & Application of Human Nutrition) at Utah State University in the Spring of 2016.

To participate, click on the link below and complete the survey. The survey should only take 5-10 minutes to complete.

Appendix F. Modified Factor Structure of Student Course Engagement Questionnaire for NDFS 1020 Spring 2016

Question: To what extent do the following behaviors, thoughts, and feelings describe you, in this course?
Please rate each of them on the following scale: 1 = not at all characteristic of me, 2 = not really characteristic of me, 3 = moderately characteristic of me, 4 = characteristic of me, 5 = very characteristic of me.

Items	Skills	Emotional	Part/Int*	Performance
Making sure to study on a regular basis	X			
Putting forth effort	X			
Doing all the homework problems	X			
Staying up on the readings	X			
Looking over class notes between classes to make sure I understand the material	X			
Being organized	X			
Taking good notes over readings, PowerPoints, or lectures	X			
Listening carefully during the lecture	X			
Come or listen to every lecture	X			
Applying course material to my life		X		
Finding ways to make the course interesting to me		X		
Really desiring to learn the material		X		
Raising my hand in class or visiting with a professor or a TA to review assignments or tests or to ask questions			X	
Having fun during the online chat, lecture and the review sessions			X	
Helping fellow students			X	

Appendix F. Continued				
Getting a good grade				X
Doing well on the tests/quizzes				X
Being confident that I can learn and do well in the class				X

*Part/Int = Participation/Interaction

Appendix G. Modified Factor Structure of Student Course Engagement Questionnaire with additional questions asking for student demographic information

Student demographic information

1) What is your gender?
    a. Male
    b. Female
2) How old are you?
    a. Under 18
    b. 18-19
    c. 20-21
    d. 22-23
    e. 24-25
    f. Over 25
3) What is your enrollment status?
    a. Full time
    b. Part-time
4) What is your ethnicity?
    a. White
    b. Non-white
5) What is your rank in school?
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
6) How many blended/online courses have you taken prior to this semester?
    a. None
    b. Once
    c. Twice
    d. Three times or more.

Modified Factor Structure of Student Course Engagement Questionnaire

To what extent do the following behaviors, thoughts, and feelings describe you, in this course*?

Please rate and select each of them on the following scale: 1 = not at all characteristic of me, 2 = not really characteristic of me, 3 = moderately characteristic of me, 4 = characteristic of me, 5 = very characteristic of me.

1) Making sure to study on a regular basis

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

2) Putting forth effort1= not at all characteristic of me

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

3) Staying up on the readings

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

4) Doing all the homework problems

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

5) Looking over class notes between getting online to make sure I understand the material

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

6) Being organized

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

7) Taking good notes over readings, PowerPoints, or video lectures

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

8) Listening carefully during the lecture

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

9) Come or listen to every lecture

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

10) Reading the textbook carefully

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

11) Applying course material to my life

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

12) Finding ways to make the course interesting to me

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

13) Really desiring to learn the material

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

14) Raising my hand in class or visiting with a professor or a TA to review assignments or tests or to ask questions

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

15) Having fun during the online chat*, the lectures and the review sessions

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

16) Helping fellow students

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

17) Getting a good grade

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

18) Doing well on the tests/quizzes

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

19) Being confident that I can learn and do well in the class

1 = not at all characteristic of me

2 = not really characteristic of me

3 = moderately characteristic of me

4 = characteristic of me

5= very characteristic of me

*For the survey given at the beginning of the semester, following changes will be made in this course to in general online chat will be deleted

Appendix H. Number of students served in on-campus and online NDFS 1020 course

	Number of students used virtual chat		Number of student served in "Crash meetup"		Number of online students joined synchronized session
	On-campus Enhanced	Online Enhanced	On-campus Enhanced	Online Enhanced	
Wk 1	0	1	No review	No review	
Wk 2	2	1	No review	No review	2
Wk 3	2	1	3	5	2
Wk 4	1	0	1	4	1
Wk 5	0	0	1	4	2
Wk 6	0	2	1	6	1
Wk 7	0	1	2	5	2
Wk 8	0	2	3	7	1
Wk 9	0	1	2	8	2
Wk 10	0	1	2	6	1
Wk 11	0	1	3	4	1
Wk 12	0	3	2	8	1
Wk 13	0	2	3	8	3
Wk 14	0	2	2	5	2
Wk 15	0	0	4	7	3
Wk 16 Finals week	No class	No class	No review	No review	No class