

Comparison of Didactic, Technical, Role Modeling, and Ethics Learning Acquisition in Undergraduate Online versus Face-to-Face Modalities

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Although much research has focused on the overall equivalency of face-to-face (F2F) versus online delivery methods, questions remain on whether the two modalities are equivalent for specific types of knowledge acquisition. Therefore, this study compared didactic knowledge, technical skills, and role modeling and ethics information learning between five online and F2F sections of an undergraduate business course over two semesters. Grades and questions on selected assignments and students' self-reported perceptions were analyzed. Results suggest that knowledge, skills, and information acquisition are similar between F2F and online classes, but online students excel at certain tasks, and F2F students excel at others.

INTRODUCTION

The invention of the World Wide Web necessarily brought about changes in education. As early as 2002, scholars discussed the practical differences between online and face-to-face (F2F) education, and predicted that the nature of the online medium would change education drastically (Smith, Ferguson, & Caris, 2002). Smith et al.'s (2002) study of instructors who taught in-person and online found that online there was a necessary emphasis on the written word, and a very different communication style between the instructor and the student. The implications of this was that online learning would bring about greater student and instructor equality, a greater need for explicit written instructions, and more work for instructors.

More recently, the 2017 Distance Education Enrollment report conveyed that student enrollment in online courses continues to increase, while higher education enrollments face a decline (Allen & Seaman, 2017). Thus, as colleges evolve from F2F course delivery to online, although education online may be different from traditional F2F classroom education, it does not necessarily have to be inequivalent. Yet, a question remains as to what a student is missing when online instruction replaces F2F. Therefore, this study aimed to compare student learning acquisition on didactic knowledge, technical skills, and role modeling and ethics information between online and F2F sections of an introductory course in computer information systems for business taught by the same professor.

This paper will first provide a review of the literature associated with online versus F2F learning acquisition. Next, the research questions and methodology for the study will be described. Results will then be presented, followed by a discussion, with recommendations for future research.

REVIEW OF RELATED LITERATURE

Much of the research comparing student learning outcomes between online and F2F delivery modes has been based on course grades, rather than specific skills acquisition, and there is some disagreement on whether these formats are equal. For example, Atchley, Wingenbach, and Akers (2013) studied a sample of over 5,000 students who attended a public university and found a significant difference between online and F2F course grades. Their results suggested students taking online courses earn more As, Ds, and Fs, while students in F2F courses earn more Bs and Cs. Xu and Jaggars's (2013) and Ashby, Sadera, and McNary's (2011) research also suggested that online and F2F formats are not equal. However, while Xu and Jaggars, who compared course grades of students enrolled in 34 community and technical colleges, found students perform worse in online courses than F2F modalities, Ashby, Sadera, and McNary found students scored higher overall on unit tests and a standardized Intermediate Algebra Competency Exam in an online development math class than F2F students, when removing students who did not complete the course.

However, many other researchers found that online and F2F formats are equivalent. For example, in a meta-analysis including 50 effect sizes derived from 45 articles comparing F2F and online learning, overall, they were found to be equal (Means, Toyama, Murphy, & Baki, 2013). Similarly, the results of a study of over 100 instructors who taught over 5,000 online and F2F courses at a large, public university suggested there is only a small difference in students' course grades between the two formats (Cavanaugh & Jacquemin, 2015). Another earlier example includes Larson and Chung-Hsien (2009) who similarly found no significant differences in the exam and final grades of students who took an introductory to management information systems class online versus F2F.

Especially in terms of didactic knowledge acquisition, online learning should theoretically be comparable, or even favorable. de Jong, Verstegen, Tan, and O'Connor (2013) studied the differences in quality of learning among public health students taking a statistics course in a traditional F2F setting versus using an online module. They administered a unit test, and found that the rate of failure was the same between online and F2F groups, and the differences in mean scores on the test were not statistically significant. In a study of nurse anesthesia students comparing an online class for teaching electrocardiogram (ECG) interpretation with an F2F version, researchers found that knowledge acquisition was comparable in both online and F2F conditions (Palmer, O'Donnell, Ren, & Henker, 2014).

In a study comparing an online versus F2F college class in sociology, it was found that students actually had more success learning didactic material F2F as evidenced by higher midterm test scores in the F2F class, but this was attributed to a selection effect whereby those with higher grade point averages (GPAs) had selected the F2F class (Driscoll, Jicha, Hunt, Tichavsky, & Thompson, 2012). However, unlike the findings of de Jong and colleagues, and opposite to the study of the sociology class, Dimeff et al. (2015) found that online training (OLT) was superior to instructor-led training (ILT) for increasing knowledge (Dimeff et al., 2015). Additionally, a study of the effectiveness of an online versus F2F version of a one-day vaccination delivery course aimed at healthcare professionals, suggested there was no difference in learning between online and F2F (Porter, 2011). On balance, these findings suggest that with didactic information and knowledge acquisition, online learning is typically as effective as F2F.

An argument could be made that F2F learning is required for effective skill-building, especially when practicing in the classroom would be beneficial. This was demonstrated in a randomized trial for delivering a curriculum to mental health therapists on how to conduct dialectical behavior therapy (DBT), where Dimeff et al. (2015) compared three conditions: OLT, ILT, and training by referring to a treatment manual (TM). They found those who had ILT felt significantly more self-efficacy in being able to conduct DBT after the training compared to the OLT and TM conditions. Though, in the study of the

ECG interpretation class in nursing students, analytic skill acquisition was found to be comparable between the online and F2F versions (Palmer et al., 2014). This finding was consistent with results from a study comparing an online vaccination delivery course with an F2F version, where students learned equally in both conditions (Porter, 2011), and a study that synthesized 17 papers, which indicated that online learning for teaching clinical skills in undergraduate nursing education was no less effective than F2F methods (McCutcheon, Lohan, Traynor, & Martin, 2015). Conversely, in the study comparing the online versus F2F sociology class, it was found that the students in the F2F course performed better on an integrating data analysis assignment which required synthesizing knowledge about population wellbeing and technological statistics, and discussing the social impacts of technology (Driscoll et al., 2012).

Demographic information has been shown to have the potential for a mediating effect on learning in F2F and online environments. For example, according to Driscoll and colleagues (2012), those with a higher GPA were more likely to select a F2F versus online course, suggesting a selection effect. In addition, while they found that year in school was not associated with selection of F2F or online course, they did find that those in the online course had taken significantly more online courses prior to the course than those in the F2F course. Students taking the online class were on average statistically significantly older, but the difference was not meaningful (mean age 22.63 versus 21.38) (Driscoll et al., 2012). The study also found that those in the F2F class were taking significantly more credits that term compared to the online class (14.95 versus 10.59), and those in the online course worked significantly more hours per week at a paying job (2.14 versus 1.52). However, in a study of health care professionals taking a one-day vaccination delivery course, there were no biases in selection of online versus F2F course by students, except that those who had had more experience with online courses were more likely to choose online (Porter, 2011).

A question remains, however, as to what a student is missing when online instruction replaces F2F. For F2F classes that include lectures, an online lecture video or online written lecture is not an identical replacement. Simply attending an in-person class and interacting with a lecturer in real-time likely confers some level of learning lost in online training. Further, the modeling of professionalism and ethical behavior cannot take place in an online, asynchronous environment. It is likely that if this type of learning is critical in the class, a F2F version would be superior to an online version. Few studies have been conducted on this topic. In a study comparing the results of delivering a professional development curriculum online versus F2F, researchers found that there were significant gains in knowledge in both conditions, and there was no significant difference between them (Fishman et al., 2013). However, it is unclear if the same results would be found in a college education setting, where role modeling plays a large role.

RESEARCH QUESTIONS

At Fitchburg State University (FSU), in their Business Administration Department, a course is held every fall, spring, and summer term titled, "Introduction to Computer Information Systems for Business" ("Intro to CIS"). This course is offered both online and F2F, and, during the timeframe of this study, was taught by the same instructor. It is a required course for the bachelor's degree in business administration. Other students take it as a free elective, such as those within the Exercise Science, Education, and Social Science majors. The learning objectives are the same in both the online and F2F versions, and these are listed in Table 1.

Before the study was conducted, it was unknown whether the online version and the F2F version of this course results in equally effective acquisition of didactic knowledge, technical skills, and role modeling and ethics information. Therefore, the purpose of this study was to determine whether or not the online and F2F versions of this course are equally successful at facilitating student learning in these areas. Specific research questions were as follow: (a) Is there a significant difference in didactic knowledge acquisition between F2F and online classes? (b) Is there a significant difference in technical skills acquisition between F2F and online classes? (c) Is there a significant difference in role modeling and ethics information acquisition between F2F and online classes?

TABLE 1
LEARNING OUTCOMES FOR ONLINE AND F2F INTRODUCTION TO COMPUTER INFORMATION SYSTEMS FOR BUSINESS COURSE AT FSU

Learning Outcome Number	Learning Outcome
After completion of this course, students should be able:	
1	To demonstrate fundamental software application skills in programs including Microsoft Word, Excel, PowerPoint, and Access in support of basic business applications
2	To define basic computer information technology hardware and software terminology
3	To compare the components and implications of graphical user interfaces within information technology from the consumer and developer viewpoints
4	To describe the fundamental patterns on which all information technology is built
5	To demonstrate an understanding of website organization, how search engines work, and how to evaluate the accuracy of web content
6	To explain basic computer software and hardware debugging strategies and workarounds
7	To describe basic privacy and digital security concepts and consider their implications
8	To recognize and discuss ethical issues and the impact of computers on society
9	To demonstrate ability to construct and present effective oral and written forms of professional communications

METHODOLOGY

In this observational, cross-sectional study, the professor of the “Intro to CIS” class taught multiple sections of the class for two semesters. Each semester included at least one F2F version and one online version of the class. The professor collected both grades and course evaluations in the form of survey responses from students in the classes, and these were analyzed to answer the research questions. Details about these procedures follow. This study was found to be exempt from oversight by the FSU Institutional Review Board for the Protection of Human Subjects in Research (IRB) because it used data already collected as part of the course.

Study Population and Class Timeline

This study was conducted at FSU, a public university located in Fitchburg, Massachusetts. FSU has between 6,000 and 7,000 full and part-time students and offers undergraduate and master’s degree programs (Fitchburg State University, 2018b).

Grades from specific assignments were collected from all students who completed “Intro to CIS” during the Fall 2016 and Spring 2017 semesters at FSU, and this population was also asked to complete an online, end-of-semester self-assessment survey. Every Business Administration student is required to take “Intro to CIS,” and although it is recommended that Business Administration students take this class during the first semester of their freshman year (Fitchburg State University, 2018a), they often take it in their sophomore or junior year because course slots fill quickly. Additionally, students from other majors occasionally take this course as a free elective.

During the time-frame of this study, all sections of this course were taught by one professor (ASP). During the Fall 2016 semester, one F2F section and one online section were offered, while one F2F and two online sections were offered during the Spring 2017 semester. During the Spring 2017 semester, one of the online sections was offered within the graduate and continuing education (GCE) program, which is

typically comprised of part-time students. All of these courses occurred over approximately 15 week periods.

Data Collection

The learning objectives for the F2F and online courses were the same, as shown in Table 1. In most cases, the instructor used identical measures to assess student learning of these outcomes. For example, students in F2F and online courses were provided with identical online workbooks that contained lessons for Microsoft Office software applications. Students were asked to complete each lesson and, to access their skills in using these applications, submit answers to the exercises at the end of each lesson for grading. To assess students' didactic knowledge acquisition, such as their ability to define basic computer information technology hardware and software terminology, F2F and online students answered identical examination questions. F2F students answered these questions on three examinations offered in-class which were distributed equally throughout the semester. Comparably, online students answered these questions through online examinations facilitated within Blackboard (Blackboard, Inc., 2018), an online course management system, at the end of each module containing a chapter from the textbook.

When it was not practical or possible due to the different formats, the professor employed similar (though not exact) measures to assess student learning and skills acquisition. For example, students in both the F2F and online courses were required to prepare a research-based PowerPoint presentation by the end of the semester. However, while F2F students presented their PowerPoint documents in-person in class, online students submitted their PowerPoint documents to the instructor and "presented" their PowerPoints to her by recording audio clips for each slide or typing notes in each slide's notes panel. Also, in the online classes, chapter "quizzes" were given weekly. However, in the F2F classes, the same quizzes were batched into "exams." Students in the online class took 12 quizzes with each quiz covering one chapter in the online section, and those in the F2F section took three exams, where each exam covered four chapters. Therefore, for the most part, the students received the same quiz and exam questions, but they did so on a different schedule.

Students were also invited to participate in an anonymous, web-based, end-of-semester survey. The survey included questions about their demographics and perceptions of obtaining the learning outcomes associated with the course.

To answer the research questions, scores on specific questions or tasks on assignments were crosswalked to indicate one of the three types of learning being studied: didactic knowledge acquisition, technical skills acquisition, or role modeling and ethics information acquisition. Scores on questions or tasks that did not crosswalk to one of the three types of learning being studied were ignored for this study. For example, data were collected from two sources: grades from specific assignments and answers to specific test questions during the course, and a final online survey that was completed by participants. The specific assignments and test questions that were subject to data collection are listed in Table 2.

TABLE 2
DATA COLLECTION FROM ASSIGNMENT GRADES CROSSWALKED TO RESEARCH
QUESTIONS AND LEARNING OBJECTIVES

Research Question	Assignment	Learning Objective Number	Assessment Measure(s)	Data Collection from Grades
1. Didactic Knowledge	Defining Terminology	2	Exam/Quiz questions	Specific quiz/exam questions
1. Didactic Knowledge	Basic Privacy/Security	7	Exam/Quiz questions	Specific quiz/exam questions
2. Technical Skills	Online Workbook for MS Office	1	Completion of and answers to Computer Skills Workbook for Office 2010 exercise questions	Grades on specific lab exercises
2. Technical Skills	GUI Comparison	3	Exam/Quiz questions	Specific essay question from quiz/exam graded on rubric
2. Technical Skills	Learning Fundamental Patterns	4	Homework assignment	Specific assignment graded with rubric
2. Technical Skills	Debugging	6	Exam/Quiz question	Specific essay question from quiz/exam graded on rubric
3. Role Modeling/Ethics	Ethical Issues	8	Exam/Quiz question	Specific essay question from quiz/exam graded on rubric
3. Role Modeling/Ethics	Quality of Final Presentation	9	Final Project	Total grade from PowerPoint presentation, as well as portion of grade allocated specifically to quality of delivery

For some of the data collection, specific questions from quizzes/exams were selected to measure the acquisition. For example, for the first research question on didactic knowledge acquisition, scores from a basic privacy and security assignment were used. These are explained in Table 3.

TABLE 3
MEASURING DIDACTIC KNOWLEDGE ACQUISITION FROM BASIC PRIVACY AND DIGITAL SECURITY QUESTIONS (F2F EXAMS, ONLINE QUIZZES)

Question	Points	Type
Privacy is the right of people to choose freely under what circumstances and to what extent they will reveal themselves, their attitude, and their behavior to others.	1	True/False
Which of the following is an example of identity theft?	1	Multiple Choice
Which Fair Information Practice provides for ways to correct your faulty credit report?	1	Multiple Choice
You discover that credit information on you is inaccurate. Which principle does this violate?	1	Multiple Choice
Data on EU Citizens is:	1	Multiple Choice
Social networking	1	Multiple Choice
When you forget your password:	1	Multiple Choice
Under most circumstances, what prevents a stranger from resetting your user password?	1	Multiple Choice
Copyrighted material may be used:	1	Multiple Choice
When using a 1-way cipher, who knows your password:	1	Multiple Choice

In the case of essay questions, the PowerPoint presentation, and more complex assignments, a rubric was used to grade the assignment, and elements from the rubric were collected as part of data collection. Table 4 shows an example for grading the graphical user interface (GUI) comparison, which was subject for data collection for the first research question about didactic knowledge acquisition.

TABLE 4
MEASURING DIDACTIC KNOWLEDGE ACQUISITION THROUGH A RUBRIC TO SCORE COMPARISON OF GUI ASSIGNMENT (F2F EXAM, ONLINE QUIZ)

Critical Elements	Exemplary	Proficient	Needs	Did not address
	4 points	3 points	2 points	0 points
Advantages Consumer	Answer evidences 3 or more points describing advantages of GUI from consumer's point of view	Answer evidences 2 points describing advantages of GUI from consumer's point of view	Answer evidences 1 point describing advantages of GUI from consumer's point of view	Did not address
Advantages Developer	Answer evidences 3 or more points describing advantages of GUI from developer's point of view	Answer evidences 2 points describing advantages of GUI from developer's point of view	Answer evidences 1 point describing advantages of GUI from developer's point of view	Did not address

Note: Maximum points possible 8.

The other source of data for this study was a final online survey completed by students. At the end of the semester, each student was asked to complete a web-based, anonymous survey administered through SurveyMonkey (SurveyMonkey, 2018). The instructor posted the link to the survey on the course site on Blackboard. This survey included two questions about each of the learning objectives (Table 1) that were rated on a Likert scale ranging from "Strongly Agree" = 5 to "Strongly Disagree" = 1. For each learning

objective, one question was regularly coded, and one question was reverse coded. For example, for the learning objective on basic terminology (learning objective 2 in Table 1), one statement was, “I feel confident that I can successfully define basic computer information technology hardware and software terminology,” and the other was, “I feel I do not understand the definition of basic computer information technology hardware and software terminology.” The survey included 18 statements. In addition, demographic information was collected, including gender, age, class level, credit hours, current GPA, major, concentration, living status (commuter or resident), hours of week working for pay, level of expertise in using technology, and preference for online classes (Driscoll et al., 2012).

Data Analysis

A descriptive analysis on the sample was conducted, and chi-square tests were used to compare distributions between F2F and online classes. To answer the research questions, the mean scores on the assessment measures and on survey domains were compared between the F2F and online classes using independent groups t-tests with the alpha set at 0.05.

RESULTS

In Fall 2016 and Spring 2017, a total of 106 students completed the “Intro to CIS” course at FSU. Forty-two percent of these students took the F2F format and 58% took the online format (F2F Fall 2016 = 24 students, F2F Spring 2017 = 20 students, Online Day Fall 2016 = 25 students, Online Day Spring 2017 = 26 students, and Online GCE Spring 2017 = 11 students). Eighty-two students completed the survey, yielding a response rate of 77%. Of these students, 40% were F2F and 60% were online (F2F Fall 2016 = 18 students, F2F Spring 2017 = 15 students, Online Day Fall 2016 = 23 students, Online Day Spring 2017 = 22 students, and Online GCE Spring 2017 = 4 students).

Sample Characteristics

Table 5 provides descriptive statistics and chi-square *p*-values for the student sample that completed the survey (n=82) with respect to categorical, demographic characteristics.

TABLE 5
DESCRIPTIVE STATISTICS AND CHI-SQUARE P-VALUES
FOR CATEGORICAL VARIABLES

Category	Level	All	Face-to-Face	Online	chi-square
		n, %	n, %	n, %	p-value
Gender	Male	50, 61%	20, 61%	30, 61%	1.0000
	Female	32, 39%	13, 39%	19, 39%	
	Other/no response*	0, 0%	0, 0%	0, 0%	
Class Level	Freshman	15, 18%	8, 24%	7, 14%	0.3488
	Sophomore	34, 41%	14, 42%	20, 41%	
	Junior	15, 18%	7, 21%	8, 16%	
	Senior	17, 21%	4, 12%	13, 27%	
	Continuing Education*	0, 0%	0, 0%	0, 0%	
Major**	Business: Marketing	6, 7%	2, 6%	4, 8%	0.1068
	Business: Management	33, 40%	15, 45%	18, 37%	
	Business: Accounting	16, 20%	8, 24%	8, 16%	
	Business: Not Decided	1, 1%	1, 3%	0, 0%	
	Non-business Major***	26, 32%	7, 21%	19, 39%	
Living Status	Commuter	54, 66%	21, 64%	33, 67%	1.0000
	Resident	27, 33%	11, 33%	16, 33%	
Tech Exp ****	No expertise	0, 0%	0, 0%	0, 0%	0.8666
	Little expertise	11, 13%	5, 15%	6, 12%	
	Adequate expertise	30, 37%	12, 36%	18, 37%	
	More than adequate exp	37, 45%	13, 39%	24, 49%	
	Expert level expertise	3, 4%	2, 6%	1, 2%	
Online Pref*****	Strongly dislike	3, 4%	3, 9%	0, 0%	<0.0001 ^{&}
	Dislike	7, 9%	5, 15%	2, 4%	
	Neither prefer nor dislike	38, 46%	22, 67%	16, 33%	
	Prefer	15, 18%	1, 3%	14, 29%	
	Strongly prefer	18, 22%	1, 3%	17, 35%	

Note: N=82. *Level not included in chi-square analysis. ** Chi-square tested all business majors versus non-business majors. ***Computer Information Systems = 2, Communications = 3, Computer Science = 1, Industrial Technology = 4, Economics = 1, English = 2, Exercise/Sports Science = 5, Game Design = 1, Interdisciplinary Studies = 1, Math = 1, Nursing = 1, Sociology = 1, Vocational Education = 1, Undecided = 2. **** Self-rated technical experience and for chi-square, collapsed into three categories: less than adequate, adequate, and more than adequate. *****For Fisher's exact test, collapsed into three categories, dislike, neither, and prefer. [&]Significant $p < .05$

Although males outnumbered females in the classes overall (61% versus 39%), the difference in their participation in online versus F2F courses was not statistically significantly different. The largest percentage of students were sophomores (41%), followed by freshmen and juniors (both 18%); the distribution of class level was also not statistically significantly different between F2F and online courses. Almost 70% of the students were business majors with the most popular concentration being management, with 32% majoring in some other department. Again, distribution by major was not statistically significantly different between online and F2F modalities. Students were more likely to be commuters (66%), and to rate themselves as having adequate (37%) or more than adequate technical

expertise (45%); the distribution of commuter status and level of technical expertise was also not statistically significantly different between F2F and online classes.

The main difference between characteristics of students who were in the online versus F2F classes is in their preference for online learning ($p < 0.0001$). Seventeen of the 18 students who said they “strongly preferred” online courses took the online course, as did 14 of the 15 students who said they “preferred” online courses. Similarly, all three who expressed that they “strongly disliked” online courses took the F2F course, as did five of the seven who indicated they “disliked” online courses. However, the largest percentage of those in the F2F course (67%) said they “neither preferred nor disliked” online courses, compared to only 33% in the online courses. Therefore, there seems to be a strong preference among some for online courses, but not the same level of strong preference for F2F courses.

Table 6 provides summary statistics for the continuous variables.

**TABLE 6
SUMMARY STATISTICS FOR CONTINUOUS VARIABLES**

Variable	All	Face-to-Face	Online	<i>p</i> -value
	mean, SD	mean, SD	mean, SD	
Age (years)	20.4, 2.0	19.8, 1.1	20.8, 2.3	0.0176*
Credit Hours	13.2, 4.4	13.0, 4.3	13.3, 4.5	0.7396
Grade Point Average	3.1, 0.4	3.1, 0.5	3.2, 0.4	0.3616
Note: N=82. *Significant $p < .05$				

As indicated in Table 6, online students were statistically significantly older than F2F students (20.8 versus 19.8, $p = 0.0176$), but this difference in age is negligible. Students in online versus F2F classes were found to carry approximately 13.2 to 13.3 credit hours on average, and have a GPA of 3.1 to 3.2 on average, with these measures not being statistically significantly different.

Analysis to Answer the Research Questions

Table 7 presents the independent groups t-tests results to answer the first research question: Is there a significant difference in didactic knowledge acquisition between F2F and online classes? The first two comparisons are from tasks in Table 2, and the third, labeled Didactic Score, is from the survey results.

**TABLE 7
INDEPENDENT GROUPS T-TEST TO ANSWER FIRST RESEARCH QUESTION***

Type of Knowledge	Face-to-Face	Online	<i>p</i> -value
	Mean, SD	Mean, SD	
Defining terminology**	27.3, 6.6	31.9, 3.6	0.0001***
Basic privacy/security**	9.1, 1.6	8.6, 1.2	0.1418
Didactic score****	16.4, 3.9	17.3, 3.2	0.2652
Note: *Research question one: Is there a significant difference in didactic knowledge acquisition between F2F and online classes? ** N=106. ***Significant $p < .05$. ****Students' self-assessment of their didactic knowledge acquisition and N=82.			

As shown in Table 7, for the defining terminology task, the online modality resulted in higher scores suggesting higher knowledge acquisition (31.9 versus 27.3, $p < 0.0001$). However, for the other task, basic privacy and security, and for the self-reported assessment, acquisition of didactic knowledge was not statistically significantly different between the two groups.

Table 8 presents the independent groups t-tests results to answer the second research question: Is there a significant difference in technical skills acquisition between F2F and online classes? The first four scores refer to tasks listed in Table 2, and the last score refers to the self-assessment from the survey.

TABLE 8
INDEPENDENT GROUPS T-TEST TO ANSWER SECOND RESEARCH QUESTION*

Type of Technical Skill	Face-to-Face	Online	<i>p</i> -value
	Mean, SD	Mean, SD	
Software applications**	12.7, 2.1	11.8, 2.6	0.0470***
GUI comparison**	4.4, 2.2	5.4, 2.1	0.0250***
Fund info tech patterns**	7.6, 1.7	7.1, 2.2	0.2019
Debugging**	6.0, 2.2	6.7, 2.3	0.1057
Skills score****	42.3, 3.2	42.2, 3.9	0.9518

Note: *Research question two: Is there a significant difference in skills acquisition between F2F and online classes? ** N=106. ***Significant $p < .05$. ****Students' self-assessment of their technical skills acquisition and N=82.

In terms of technical skills, for the software applications task the F2F condition resulted in a statistically significantly higher score (12.7 versus 11.8, $p = 0.0470$), but in a practical sense, the scores were very similar. For the GUI comparison, the online condition resulted in a statistically significantly higher score (5.4 versus 4.4, $p = 0.0250$), but again, in a practical sense, the scores were very similar. There was no statistical difference between performance in the online versus F2F courses in the other two tasks, and in terms of the students' self-assessment of their technical skills acquisition.

Table 9 presents the independent groups t-tests results to answer the third research question: Is there a significant difference in role modeling and ethics information acquisition between F2F and online classes? The first three scores refer to tasks listed in Table 2, and the last score refers to the self-assessment from the survey.

TABLE 9
INDEPENDENT GROUPS T-TEST TO ANSWER THIRD RESEARCH QUESTION*

Type of Information	Face-to-Face	Online	<i>p</i> -value
	Mean, SD	Mean, SD	
Ethical issues**	4.3, 2	4.3, 2.4	0.9208
Quality of final presentation**	92.5, 5.5	85.6, 19.1	0.0092***
Delivery of final presentation**	7.5, 0.5	6.9, 1.9	0.0194***
Role model and ethics score****	17.4, 3.7	16.7, 3.7	0.4291

Note: *Research question three: Is there a significant difference in role modeling and ethics information acquisition between F2F and online classes? ** N=106. ***Significant $p < .05$. ****Students' self-assessment of their skills acquisition and N=82.

Table 9 highlights that there was a statistically significantly higher score in the quality and delivery of F2F students' final presentations compared to those of the online students (quality: 92.5 versus 85.6, $p = 0.0092$; delivery: 7.5 versus 6.9, $p = 0.0194$) indicating higher information acquisition in the F2F modality. However, for the other component, ethics information, and for students' self-reported assessment of their acquisition of role model and ethics information, there was no statistically significantly difference between the two groups.

DISCUSSION

In this study, for the most part, didactic knowledge acquisition was found to be similar between F2F and online classes, although the online classes performed statistically significantly higher on the defining terminology task. Technical skills acquisition was found to also be similar between the two modalities, but the F2F classes excelled significantly at the software application task, and the online classes excelled significantly at the GUI comparison task. Finally, role modeling and ethics information acquisition was also found to be similar between the two groups except with respect to the delivery and overall quality of the final presentation, which was significantly superior in the F2F classes.

The overall findings of similarities in knowledge, skills, and information acquisition between F2F and online modalities in an undergraduate business course is consistent with the overall findings in the scientific literature that suggests that these modalities are comparable (Cavanaugh & Jacquemin, 2015; de Jong et al., 2013; Fishman et al., 2013; Larson & Chung-Hsien, 2009; McCutcheon et al., 2015; Means et al., 2013; Palmer et al., 2014; Porter, Pitterle, & Hayney, 2014). The finding that didactic knowledge and technical skills acquisition were very similar between modalities mirrors the results of the study of public health students in a statistics course, and the study of nurse anesthesia students learning ECG interpretation (de Jong et al., 2013; Palmer et al., 2014). However, it contradicts the findings from the sociology class where didactic learning was more successful in the F2F environment; however, the authors noted that those with higher GPAs chose the F2F course, whereas that phenomenon did not occur in the current study (Driscoll et al., 2012).

One study cited earlier, however, did find that OLT was superior to ILT for increasing a certain type of knowledge (Dimeff et al., 2015). This observation reflects a potential mechanism in the current study. For didactic knowledge, the online classes actually outperformed the F2F classes on the defining terminology task. For technical skills, the online classes outperformed the F2F on the GUI comparison task. Success on both these tasks was based largely on reading and understanding the written material. It is possible, then, that certain types of didactic knowledge and technical skills learning could be superior in the online environment. It is likely that the type of knowledge or skills being taught would need to be well-defined, circumscribed, straightforward, and easy to evaluate in order for the online modality to be superior to F2F. A previously cited study that found online algebra course scores to be higher than F2F scores, seems to support this notion; however, that study removed students who did not complete the course from the analysis, so the results may be biased by this (Ashby et al., 2011). Although a study cited earlier found there to be different grade distributions between students who took online and those who took F2F classes, given the results of the current study, this may have been a function of students preferring online classes (Atchley et al., 2013). Therefore, it may not be a comment on whether or not there is any qualitative difference in their learning. However, it is clear that both modalities are comparable for the delivery of this type of information.

The finding that role modeling and ethics information acquisition was largely similar between the modalities, but differed greatly with respect to the PowerPoint presentation task, seems to support the idea that certain types of learning might be superior in the F2F environment. This appears to be learning that involved the demonstration of a technical task while also role modeling values. In the study cited previously at the technical college, students were found to have scored significantly worse in the online classes compared to F2F (Xu & Jaggars, 2013), but this may have been because the focus of the coursework was on teaching technical tasks that required also the role modeling of values, such as in courses for healthcare providers and teachers. The level to which F2F might be a superior environment for teaching these types of skills may have to do with the level of the component role modeling of values plays. For example, one study of teaching clinical skills to nurses found that students were equally successful when they took classes online versus F2F (McCutcheon et al., 2015). If the clinical skills being taught did not have a large role modeling component, it would make sense that the level of success of the online and F2F classes would be similar.

An interesting descriptive finding was that students overall showed a preference for online courses, and did not appear to try to take F2F courses to avoid online courses. As more higher education institutions begin to offer or expand online curricula, many feel a sense of resistance from faculty, administration, or other stakeholders involved. Mitchell, Parlamis, and Claiborne (2015), for example,

suggested that (a) cultural assumptions and values, (b) concerns about unknown, loss, and failure, (c) concerns of interpersonal relationships disruptions, and (d) fears about external impact are four potential reasons that faculty resist online education. However, the results of this study and others suggest that faculty should be embracing online learning with more enthusiasm. In most cases, online learning is equivalent to F2F learning, and in some cases, it could even be better. Further, many students of today have grown up with the internet, and have experience with online courses even in high school (Kazu & Demirkol, 2014; Murphy, Rodriguez-Manzanares, & Barbour, 2011; Picciano & Seaman, 2010). When online learning was new, the challenge was to demonstrate whether or not it was equivalent to F2F learning overall. Now that this equivalency has been established, the new challenge is to adapt these online learning environments to be more student-centered.

This study is not without limitations. The results of this study are potentially generalizable to other students who learn at state universities that operate in the U.S., have a student base similar to that of FSU, and offer both F2F and online classes. However, the results may not be generalizable to other types of students and other settings. Future researchers should consider studying other types of students in other settings, and contemplate more in-depth studies to determine the exact type of didactic knowledge and technical skills acquisition that is better facilitated in an online environment. Better ways to successfully role model within online classes is another important subject for future study.

CONCLUSION

In conclusion, in the current study, didactic knowledge, technical skills, and role modeling and ethics information acquisition were similar between the F2F and online classes, but students in the online environment excelled on certain tasks within these domains, and students in the F2F environment excelled on others. Future researchers should seek to better understand what exact material, when presented online, results in superior learning, and what type of material is better suited for learning in the F2F format.

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