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Factors Contributing to the Improvement of University Students' Academic Performance and Knowledge Retention in an Online Learning Environment

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Abstract

Online learning suffers from lower academic performance and lower knowledge retention when compared to face-to-face learning. This study investigates various factors that can contribute to the improvement of academic performance and knowledge retention among university students in an online learning environment. Tests were used to assess students' academic performance and knowledge retention. The results show that academic performance and knowledge retention are significantly dependent on the courses offered, the time at which learning modules are delivered during the course, and the duration of the learning material associated with each outcome. Data also suggest that utilizing online technology-based tools like is associated with lower academic achievement and lower retention levels. Better students' background knowledge was associated with better information retention. Additionally, female students showed a trend towards better assessment grades, while better mother's education was associated with better academic performance and better knowledge retention in an online learning environment.

Keywords: Higher Education, Online Learning, Academic Performance, knowledge retention

1. Introduction

Online education offers students access to learning materials in a flexible and convenient manner, irrespective of their geographic location (Delaney & Fox, 2013; Roll et al., 2018). Additionally, online learning eliminates time restrictions, making it possible for students to access classes at any time of their choosing (Paul & Jefferson, 2019a). This type of learning environment also promotes the ability to engage various types of students and renders the process more student-centered (Appana, 2008; Drab-Hudson et al., 2012; Lee & Choi, 2011; Zimmerman, 2012). Generally, faculty members utilizing online delivery methods largely resorted to sharing slide decks with students, setting up video conference classes with virtual white boards, organizing group discussions in break-out rooms, and using shared-annotation documents. There is no doubt that these tools have had great positive impact to learners in the absence of face-to-face alternatives.

Despite the aforementioned benefits and despite the fact that instructors are implementing several active teaching strategies during their online sessions, online learning suffers from a number of well-documented drawbacks, which may have been exacerbated by the sudden shift to online delivery at the hands of untrained faculty and staff, irrespective of their best attempts to offer the highest quality education, adapting their curricula to a new mode of delivery in record times (Farrell & Brunton, 2020). Students in online learning environments are more vulnerable to attrition (Woodley & Simpson, 2014) displaying lower knowledge retention levels and lower academic achievement in comparison to in-person traditional degree programs (Garratt-Reed et al., 2016). The lower completion rates in online classes can be attributed to a number of factors that have been the focus of an ongoing debate in the field of learning science. These factors can be grouped into four main categories. The first category relates to the course of instruction, its nature (major vs. elective), difficulty level (Wladis et al., 2017), and the course design (Ice et al., 2011). The second relates to students' personal aptitudes towards learning, including the academic integrity, self-discipline, lack of confidence, and academic and cultural background (Almaiah et al., 2020; Chen & Jang, 2010; Wehmeyer et al., 2003). The third category is concerned with efficiency of online learning, which is influenced by the instructors' presence, teaching methodology, and the ability to facilitate learning, which impact students' academic achievement and knowledge retention

(Fredrickson, 2015; Garratt-Reed et al., 2016; Holley & Oliver, 2010; Ituma, 2011). Additionally, the instructors' digital skills play a prominent impact on students' learning in an online learning environment, with the lack of training and knowledge in technological tools negatively impacting the learners' academic abilities (Ice et al., 2011). This is further exacerbated by any lack of academic orientation, resources, or technological support offered by the institution (Holley & Oliver, 2010; Otter et al., 2013). The fourth factor relates to communication and social interaction, as studies reveal that students attending online classes felt disconnected, isolated, and under-valued by their instructors and universities, leading to a negative impact on the quality of interaction with their peers and their instructors (Brown et al., 2015; Mallman & Lee, 2016; Zhang & Perris, 2004).

Therefore, it is critical for higher education institutions to investigate and understand the multiple factors impacting students' academic achievement and knowledge retention in online classrooms. These two measures (academic achievement and knowledge retention) are considered the main indicators of the constructiveness and effectiveness of higher education online academic programs (Kell et al., 2013). The current study examines multiple factors that potentially contribute to the improvement of university students' academic performance and knowledge retention to ensure a favorable online learning experience.

For this, the current study seeks to answer the following question:

What are the factors that contribute to the improvement of university students' academic performance and knowledge retention in an online learning environment?

2. Methodology

2.1. Sample Description

180 students made up the study's final sample, of which 133 were female (73.9%) and 47 were male (26.1%). The average age of the students was 25.32 (18–47; SD=6.64). When it came to the participants' parents' higher education, 17.2 percent of the participants' fathers had a college degree compared to 16.7 percent of the mothers.

Six separate courses were offered to the students according to their major Counseling and Guidance, Business Economics, English Language and Composition, Family Health, Upper Intermediate English, and Educational Classroom Management. In each course, the study participants were randomly divided into two sections. Each participant participated in one course, based on his/her major, and made part of four sessions where four learning outcomes were taught and assessed.

Six professors from the departments of Business, English, Computer Science, Graphic Design, Health Sciences, and Education made up the study's final sample of instructors. The final sample involved one male and four female instructors with a variety of specialties, and had an average age of 35.73 (SD=6.87); the years of experience of the participating instructors in the study ranged from 2 to 25. From this considered sample, 43.3% of the instructors demonstrated proficiency in digital skills.

2.2. Study Design

The purpose of this study was to shed light on the factors that contribute to the improvement of university students' academic performance and knowledge retention in an online learning environment. For this, this study adopts a quantitative research design.

To elucidate, the current study is quantitative in nature since it seeks to answer a relational question between two variables within the research (Williams, 2007). The first variable, the independent variable, refers to the inclusion of technology-based tools in teaching in an online learning environment. This independent variable is expected to improve the two dependent variables, which

are the students' academic performance and students' knowledge retention in an online learning environment.

2.3. Data Collection Tool

As Creswell (2003) states, quantitative research studies engage methods of investigation like surveys, tests, and experiments that gather information on preset instruments and produce statistical data (Creswell, 2003). For this, this study used tests to assess students' basic knowledge, academic performance and knowledge retention.

A pretest specific to the course being taught (Baseline Assessment) was used to assess students' basic knowledge in the explained learning outcomes (example may be found in supplement material). By the end of the intervention for each learning outcome in each course, and to test the students' academic performance, a posttest (Moodle Online Quiz), specific to each learning outcome in each course was used. Above that, and in order to measure students' knowledge retention, another pretest was used, one month after the experiment took place. All the used tests were graded over 100.

2.4. Procedure of Data Collection

The study was conducted at the Modern University of Business and Science, Lebanon, during the 2021 Summer semester. Six academic courses from six different Departments were selected for this study. The selected courses were courses from the Departments of English, Business, Computer Science, Graphic Design, Education and Health Sciences. The choice of the included courses on the study was based on the instructors' interest, digital knowledge and number of students in each course. Instructors of the aforementioned courses, that were involved in the study were trained by the researchers on the use of the educational technology tools and online educational applications. The tools used in this study were:

1. Random Wheel, from the platform "Wordwall". This tool allows the instructor to choose a random name or option during an online session by spinning a random visual wheel. The purpose of using this tool in this study was to ensure students' engagement during the online session.
2. Online Polling, from the platform "Mentimeter". This tool gives the students the chance to make a decision on the spot about a certain topic/inquiry/discussion in the course during the online session. The purpose of using this tool in this study was to give a primary evaluation about the knowledge acquired by the students and their engagement during the online session.
3. Wordcloud, from the platform "Mentimeter". This tool allows the students to openly express their opinions and knowledge about a given topic throughout the online session. The purpose of using this tool in this study was to ensure students' engagement during the online session.
4. Ranking, from the platform "Mentimeter". This tool allows students to rate various options related to a certain topic during the online session. The purpose of using this tool in this study was to gather students' feedback on the online session.

As mentioned, six courses were considered for this study. Then, each course was divided into two sections (A & B) and broken down into its component units that each represent a learning outcome.

Sessions were randomly assigned to section A (n=420; 58.3%) and to section B (n=300; 41.7%); 17.8% of sessions were related to a course of Business Economics, 23.3% Counseling and Guidance, 19.4% English Language and Composition, 18.3% Upper Intermediate English, 13.9% a Family Health course, and 7.2% to an Educational Classroom Management course. Moreover, 43.3% of sessions were taught by instructors with proficiency in computer literacy. Then, four learning outcomes from each course were considered for the study in the two sections. In both sections for each course, students took a pretest (a baseline assessment), assessing their basic knowledge in regard to the chosen learning outcomes to ensure that the students have similar academic level.

Each course section later alternated using the above mentioned online technology-based tools during the online sessions, allowing instructors to teach the modules within each course either with or without these tools (traditional online teaching). For instance, section B of the English course would use the online learning tools for the first unit and the traditional tools for the second unit, when section A of the same English course used conventional online teaching to teach the first unit, and used the online technology-based tools to explain the second unit and so on. This crossover method is useful because it will allow in decreasing interindividual variability and confounding bias in an experimental design: each subject acts as his or her own control, and that a smaller number of participants are required in comparison to parallel-group studies (Sibbald & Roberts, 1998).

Upon the completion of each learning outcome in each of the six included courses in the study, the academic performance of the students participating in the research was measured through a posttest (an 8 questions online Moodle quiz respective to each learning outcome in each course). So, as result, for each course all the four learning outcomes were assessed, with duration between 2 and 3 weeks. As for the used methods, Mentimeter was used in 28.8% of cases, Random Wheel in 65.3% on a first round and 59.7% on a second round, Pooling in 44.2%, Wordcloud in 54.7%, Ranking in 28.3%.

The retention of information was measured one month after the course completion, including questions covering all the tackled learning outcomes. All assessments were graded over 100.

2.5. Ethics

The study was driven according to the guidelines specified in the Declaration of Helsinki, and all procedures were approved by MUBS Internal Review Board (approval reference number no. MU-20210503-23). Additionally, written informed consents were obtained from all participants.

2.6. Statistical Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 25.0. The descriptive analysis showed means, standard deviations (SD), medians and interquartile range (IQR) for continuous variables, frequencies and percentages for multinomial and dichotomous variables. A General Linear Modeling Repeated Measures ANOVA was conducted,

taking into account measurement repetition among students, applied to assessment and retention (as separate dependent variables). In addition, a MANCOVA was conducted taking both dependent variables in one model. In all cases, adjustment over students and instructors characteristics, baseline assessment, and parental education was conducted; a p-value <0.05 was considered significant.

3. Results

3.1. Student Assessments

Baseline assessment mean was 63.12 (SD=19.32) [Median=61.25; IQR 50 to 80], while the mean for assessments conducted after each learning outcome was 71.27 (SD=20.45) [Median=75; IQR=60-82]. Retention exam grades ranged from 0 to 100, with a median of 50 (IQR 50 to 100).

3.2. Assessment Associated Factors

Using a Generalized Linear Model with repeated measures to take into account the learning outcomes repetition among students (adjustment over students and instructors characteristics, baseline assessment, parental education), we found that 3 factors were associated with a lower assessment grade. These three factors are the use of Wordcloud in online sessions, the lack of university education of mothers and earlier learning outcomes that are taught at the beginning of the course. The data also show that other online technology-based tools were not significantly associated with the low assessment grade.

two courses were associated with the highest assessment grades (Counseling and Guidance, Classroom Management) (Table 1). Other variables such as instructors' characteristics, students' characteristics, father education, and other digital tools did not have a significant correlation with the dependent variable, and were thus removed from the model.

Table 1

Assessment Associated Factors

Parameter	B	95% Wald Confidence Interval		Sig.
		Lower	Upper	
Course Counseling and Guidance	6.816	.899	12.732	.024
Course Classroom Management	10.331	3.305	17.357	.004
Mothers Education Level Not declared vs University	-15.278	-27.672	-2.883	.016
Learning outcome=1 st versus last	-6.468	-11.421	-1.515	.010
Learning outcome=2 nd versus last	-9.471	-14.950	-3.992	.001
Learning outcome=3 rd versus last	-7.957	-13.569	-2.346	.005
Wordcloud use	-5.387	-10.117	-0.657	.026
Baseline Assessment Grade	.117	-.002	.235	.053

3.3. Factors Associated with Retention

Retention was inversely and significantly correlated with the use of Wordcloud, earlier learning outcomes that are taught at the beginning of the course, and the nature of the course: courses of Business Economics and Counseling and Guidance (Table 2). Other variables such as instructors' characteristics, students' characteristics, parents' education, and other digital tools did not have a significant correlation with the dependent variable, and were thus removed from the model.

Table 2

Factors Associated with Retention

Parameter	B	95% Wald Confidence Interval		Sig.
		Lower	Upper	
Course Business Economics, Analysis and Forecasting	-21.069	-41.965	-.172	.048
Course Counseling and Guidance	-22.162	-35.763	-8.561	.001
Learning outcome=1 st versus last	-14.075	-23.195	-4.954	.002
Learning outcome=2 nd versus last	-28.956	-39.859	-18.053	.000
Learning outcome=3 rd versus last	-18.868	-28.972	-8.764	.000
Wordcloud use	-11.358	-22.861	0.146	.053

3.4. Multivariate Analysis of Dependent Variables Correlates

Based on the multivariate analysis (Table 3), Business Information Systems major and learning outcome 2 were associated with the lowest grade, while other majors were associated with higher grades; female gender of students and of instructors showed a trend towards better assessment grades. For retention, lowest values were shown for Economic Information system and Arabic education, with all majors having lower retention compared to English. Duration of the learning material associated with the learning outcomes of 3 hours (versus 2), later learning outcomes (4 versus the first 3 others), better grade on baseline assessment and university level of mother's education were associated with better retention. Regarding digital tools, none were associated with assessment grades, while using wordcloud was associated with lower retention (Table 3). Variables such as other instructors' characteristics, other students' characteristics, father education, and other digital tools did not have a significant correlation with the dependent variables, and were thus removed from the respective models.

Table 3
Multivariate Analysis of Dependent Variables Correlates

Dependent Variable	Parameter	B	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
ASSESSMENT	[Student major=Business Administration]	24.662	.049	.073	49.250
	[Student major=Business Information Systems]	-43.439	.014	-78.098	-8.780
	[Student major=Computer Science]	20.092	.080	-2.454	42.638
	[Student major=Master of Business Administration]	30.894	.005	9.506	52.282
	[Student major=Teaching Diploma in Education - English Elementary]	33.251	.004	11.003	55.499
	[Student major=Teaching Diploma in Education - Math and Science Elementary]	21.186	.017	3.789	38.582
	[Student major=Teaching Diploma in Education - Science Secondary]	19.851	.022	2.873	36.829
	[Instructor gender=Female]	30.984	.060	-1.308	63.276
	[Gender student=Female]	7.680	.074	-.762	16.121
	Baseline Assessment Grade [Learning outcome=2]	.160	.024	.021	.299
RETENTION	[Student major=BAL MBA]	-47.122	.008	-81.585	-12.658
	[Student major=Banking and Finance]	-69.848	.022	-129.428	-10.269
	[Student major=Business Information Systems]	-122.076	.000	-188.176	-55.976
	[Student major=Early Childhood Education]	-29.368	.030	-55.794	-2.942
	[Student major=Education Arabic and Social Studies]	-89.140	.002	-144.980	-33.300
	[Student major=Education Math and Sciences]	-24.240	.065	-49.994	1.515
	[Student major=Master of Business Administration]	-50.325	.016	-91.115	-9.535
	[Student major=MBA in Educational Management]	-36.215	.045	-71.620	-.811

[Student major=Teaching Diploma in Education - Math and Science Elementary]	-30.245	.074	-63.423	2.934
[Mother Education=Not declared vs University]	44.289	.013	9.357	79.220
[Mothers Education=Non University vs University]	-11.411	.097	-24.885	2.062
Baseline Assessment Grade	.254	.060	-.011	.519
[Learning outcome=1 vs 4]	-13.823	.026	-26.004	-1.642
[Learning outcome=2 vs 4]	-36.650	.000	-48.942	-24.358
[Learning outcome=3 vs 4]	-19.265	.003	-32.011	-6.519
[Duration=2.0 vs 3.0]	-26.148	.031	-49.872	-2.425
Using Word cloud	-14.648	.029	-27.805	-1.491

Factors Affecting Dependent Variables

4. Discussion

This study aimed to explore factors influencing academic achievement and knowledge retention of university students in an online learning environment. Our data suggest that the use of online educational tools, the nature of the course of study, students' mothers' educational level, the timing of the learning outcome, the duration of the learning material associated with the learning outcome, students' background knowledge, and students' and instructors' gender, are all factors that have a direct influence the level of academic achievement and knowledge retention among students in an online learning environment.

Using digital educational tools (WordCloud) was shown to be associated with lower academic achievement and lower information retention levels, compared to those who did not use the tools during the online sessions. While this result may be counter-intuitive, it is in line with results from other studies showing that the use of digital tools in educational settings had a negative impact on students' learning. One potential interpretation is that digital tools led students to take shortcuts instead of investing any effort in learning the intended concepts. Some studies suggest that online learning tools result in students being less attentive to the material being taught (Purcell et al., 2013). Other studies showed that using digital educational tools can positively affect academic achievement and retention of information through its impact on working memory, long-term memory and interactivity (Ibrahim & Al-Shara, 2007; Zeglen & Rosendale, 2018). Additional studies will be necessary to explain the reasons behind these findings.

Counseling and Guidance and Classroom Management courses were associated with better achievement among students when compared to the other courses. Business Information Systems major was associated with the lowest assessment grade averages. In addition, in an online learning environment, an inverse significant correlation was found between retention of knowledge in the courses of Business Economics and Counseling and Guidance and lowest values of retention were shown for Economic Information System and Arabic Education, with all majors having lower retention levels compared to English. Neither the achievement nor the retention level was similar among different courses due to differences in the level of difficulty of the course and the major in which it's offered. Discrepancy between courses is aligned with other studies 'outcomes for the

difficulty or the level of the academic course in an online learning environment impact students' experience (Ice et al., 2011). Additionally, the course design in an online learning environment has impact on students' achievement. Duration of the learning material associated with the learning outcomes of 3 hours (versus 2) was associated with better retention of information similarly to other studies showcasing the effect of the course design on academic achievement in an online learning environment (Garratt-Reed et al., 2016).

Mothers' education affects the performance of the children similar to other studies showing positive correlation between academic performance in an online learning environment and mothers' years of schooling. Parents' past educational achievement becomes a benchmark for children to perform better; in contrast, those who graduated with a minimal degree generally do not have the aspirations to raise higher-achieving students (Chiu & Khoo, 2005; Sutor et al., 2008). Mothers' education was associated as well with better retention.

Earlier learning outcomes in an online learning environment were students hadn't get used to the teacher, were associated with lower assessment grades, the literature shows a positive relation between instructor's acceptance and academic achievement (Kořir & Tement, 2014). Acceptance of the instructor needs more time in an online environment compared to face-to-face learning as shown in the literature where students studying online had lower academic achievement compared to students taking the same course face-to-face in the midterms (earlier learning outcomes assessment) but the results were different during the finals (Paul & Jefferson, 2019b). Retention was inversely and significantly correlated with earlier learning outcomes and later learning outcomes (4 versus the three others) was associated with better knowledge retention among the students.

Better grade on baseline assessment, indicating background knowledge in the course was associated with better retention, some studies showed that prior knowledge significantly influenced student achievement, but no study assessed the effect of prior knowledge on the retention of information (Hailikari et al., 2008).

Female gender of students showed a trend towards better assessment grades, similarly to other studies where female students were found to outperform their male counterparts (Parajuli & Thapa, 2017; Pirmohamed et al., 2017). Students of female instructors were shown as well to have better assessment grades, unlike other studies where gender plays only a minor role in determining college student achievement (Hoffmann & Oreopoulos, 2009). Nevertheless, some studies provide evidence that gender role models matter to some college students. A same-sex instructor increases average grade performance by at most 5 percent, noting that 73.9% of participants in this study were females (Patterson et al., 2021).

5. Conclusion

Many factors influence the academic achievement and the retention of information in the online learning environment. Achievement and retention significantly differed among courses: retention was inversely correlated with earlier learning outcomes and later learning outcomes was associated with better retention; moreover, longer duration of learning outcomes was associated with better retention of information. Using some educational tools was shown to be associated with lower academic achievement and lower retention compared to those who did not use it. Better grade on baseline assessment, indicating background knowledge in the course was associated with better retention. Female gender of students showed a trend towards better assessment grades, while mother's education affected the performance of the students and the retention of information. Further understanding of factors affecting academic achievement and retention can contribute to a better learning experience.

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