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Evaluating Online Learning Strategy and Assessment Methods in the Course of Human Biology for the Preparatory Year Medical Students During COVID-19 Pandemic Lockdown

Shimaa E. Elaraby¹, Fatma M. Ghoneim², Ayman Z. Elsamanoudy^{3,4}

¹Medical Education Department, Faculty of Medicine, Suez Canal University, Ismailia, EGYPT

²Faculty Development Unit, Medical Education Department, Fakeeh College for Medical Sciences, Jeddah, SAUDI ARABIA

³Department of Clinical Biochemistry, Faculty of Medicine, King Abdul-Aziz University, Jeddah, SAUDI ARABIA

⁴Department of Medical Biochemistry and Molecular Biology, Faculty of Medicine, Mansoura University, Mansoura, EGYPT

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ABSTRACT

Since the lockdown caused by the COVID-19 crisis, there has been insufficient reporting regarding the evaluation of students' performance in biology courses in medical schools. This study is designed to evaluate the online learning strategy by examining its effects on preparatory medical students' performance. The target population included preparatory year medical students ($n = 115$) at Fakeeh College for Medical Sciences in Saudi Arabia. The human biology course (15 weeks) was taught using two different teaching strategies due to the lockdown and home-schooling decision. The first eight weeks were conducted on campus and the remaining seven weeks were conducted using online interactive lectures and virtual classrooms via Blackboard platform. The latter is the formal platform used by the college for online teaching. Continuous and final assessment results were used to assess student performance and to evaluate the effects of online learning on students' knowledge and skills. The results of the final examinations demonstrated a significant increase ($p < 0.05$) in student performance. The mean of the students' scores increased by 1.28 in the final examinations compared to the midterm examinations for female students ($n = 73$). Similarly, there was a significant increase in the male students' scores in the final examinations. The mean increased by 1.24 in the final compared to the midterm examination for male students ($n = 42$). Online assessment tools are proved to be successful assessment methods and could provide additional non-traditional methods for students' performance evaluation. Furthermore, with online learning and assessment, students' performance is enhanced.

Keywords: *Online learning strategy, Evaluation, COVID-19 pandemic lockdown, Medical education, Biology*

CORRESPONDING AUTHOR

Shimaa E. Elaraby, Department of Medical Education, Faculty of Medicine, Suez Canal University, P.O. Box 41522, Ismailia, Egypt

Email: shimaa80me@yahoo.com

INTRODUCTION

Online learning has been highly recommended in the past few years. It is seen as an efficient alternative to face-to-face learning. The recent lockdown caused by the COVID-19 crisis has had an impact on educational methods. Many institutions were unable to perform face-to-face teaching and, therefore, teaching and learning activities were switched to virtual lectures using an online platform to ensure that students' education continued without interference. Well-planned online learning courses are different from online courses that are conducted during a crisis and include social support and engagement (1).

This situation of unplanned online learning demanded necessary procedures to make a safe learning environment for teachers and students (2). There are currently few studies exploring online learning during the recent crisis; however, online learning is assumed to be of lower quality than face-to-face learning, despite research demonstrating otherwise (3).

Educational institutions use technology in learning and assessment to fill the gaps of training. Technology-enhanced learning (TEL) tools can help students to achieve the learning outcomes related to communication, identifying needs, controlling learning and getting feedback (4). The assessment structure for medical students should be rigorous in order to ensure the quality of performance and future impact on their career in the healthcare system (5). Such decisions are collected from several points of students' assessment and are made based on a variety of sources of information. Policies and procedures are developed to direct the panel and panellists to help them reach such decisions (6).

Different types of assessments are used to measure students' achievement in different domains. In the traditional face-to-face assessment, all the assessment methods must be valid, reliable and fair to be suitable to measure the course learning outcomes

(CLOs) (7). However, the online assessment methods' psychometrics are still under investigation. Some studies encouraged the use of computer-based assessment because there are no threats to the validity caused by the students' preferences and attitudes (8). CLOs are assessed directly by collecting data from students' performance in quizzes, student prepared presentations (SPP), assignments, team-based learning (TBL) with individual readiness assurance test (IRAT) and team readiness assurance test (TRAT) (9), portfolios and written examinations. However, indirect assessment of learning outcomes is of vital importance in measuring student achievement (10). It provides evidence of students' perception of learning and achievements. Indirect assessment can be measured by surveys, focus groups or interviews.

Because the online shift of the teaching and assessment was mandatory during COVID-19, investigating the impact of this shift was necessary. Therefore, the current study aims to compare the students' performance in the preparatory year of the medical school at Fakeeh College for Medical Science during the period of complete COVID-19 lockdown where online learning was the only used learning strategy, by determining whether the online learning affected students' performance in their final assessment. Since several studies have revealed that there is a difference in using technology between males and females, gender differences were also assessed in the current study.

METHODOLOGY

Study Context

This is a quantitative correlational study, where the effect of online learning on students' achievements in a biology course was explored. The study was conducted at Fakeeh College for Medical Sciences, Jeddah. The target population was the preparatory-year medical students.

The number of students was 115 (73 females and 42 males). The students were separated into males' and females' sections. The duration of the biology course was 15 weeks. The human biology course was taught using two different teaching strategies due to the lockdown and home-schooling decision. The first eight weeks were conducted on campus, during which the instructional methods included interactive lectures and case-based discussion (CBD). Assessment methods for this part were quiz 1, TBL (IRAT, TRAT, CBD), midterm multiple-choice questions and short essays in the form of a written examination. The following (and final) seven weeks' duration included online synchronous interactive lectures and virtual classrooms via Blackboard as it is the learning management system (LMS) and the formal platform used by the college for online teaching. Blackboard gives students the opportunity to interact using voice and video. It includes virtual classrooms which allow two-way communication between students and the instructor. The instructor can upload PowerPoint slides and use whiteboard and breakout groups. In the chat room, the instructor can post questions and students can post answers. Students also can press the "raise hand" button to ask questions verbally. Continuous and formative assessments, as well as online dry objective structured practical examination (OSPE) stations, were carried out at the end of the course as shown in Table 1. The instructors designed blueprints, including the practical sessions and distributed the stations. The stations were in the form of

coloured photos of histology slides and short-answer questions based on scenarios. OSPE is mainly testing the higher cognitive intellectual and problem-solving skills of the students. The students received orientation sessions about the use of these virtual classes before the implementation of the virtual classrooms.

Table 1: The course plan in the biology course

Time	Teaching methods	Assessment methods
Face-to-face learning	Interactive lectures on site	Formative assessment
	CBD	Quiz 1 TBL (IRAT-TRAT and CBD) Midterm written examination and lab manual
Online learning	Interactive lectures online	Formative e-assessment
	CBD	Quiz 2 e-Portfolios (assignments, reflection, SPP) Final examination (theoretical and OSPE)

The details of the courses including the title, credit hours, level, semester and number of students is shown in Table 2. The assessment plan illustrating and describing the assessment methods, their timing and the weight of each method is shown in Table 3. Regarding the oral SPP, we observed the students while they were presenting a previously prepared topic online and used a rubric for their evaluation.

Table 2: The courses' details

Course title	Credit hours	Year	Semester	Number of students
Human biology	3	Preparatory	Second	115

Table 3: The assessment plan in the biology course

Assessment task	Week due	The proportion of total assessment (%)
Oral presentation (SPP)	During the semester	5
TBL (IRAT-TRAT and CBD)	During the semester	10
Midterm examination	8	20
E-Portfolios (assignments, reflection)	During the semester	15
Quizzes	During the semester	10
Final examination (theoretical and OSPE)	14–15	40
Total		100

Sample Size

We used Epi Info for calculating the sample size. We found the previous study of Bata-Jones and Avery which has the mean (77.8 in the online group and 75.3 in the control group) and the standard deviation (SD) is 8.7 (11).

Study Instruments

The data were collected by calculations of students' scores in summative examinations (midterm and final examinations). These two examinations contained the same types of questions (multiple choice questions [MCQs], extended matching questions [EMQs] and essay). The instructors constructed blueprints and the items were revised by a medical educationist. Students received enough training on online assessment methods through conducting mock examinations in the practical part and formative assessment in the theoretical part. Furthermore, feedback on students' performance was given. Electronic examinations included MCQs, EMQs and quizzes which were conducted via Blackboard. These methods mainly covered the cognitive domains and the cognitive part of the psychomotor domain. The most important characteristics of e-examinations are as follows: All students enter the examinations on the same date and time of each examination, and no one is given permission to return back to the question

after submitting the answer. In addition, the estimated time was 1.5 minutes per question, and questions and answers were randomly shuffled among the students. If any issue occurred regarding Internet connection, the programme director was contacted immediately, and the timer was activated with completion choices. All the data were anonymous. Moreover, the students' performance before the midterm examination was compared to their achievement after the midterm examination.

Statistical Analysis

Data analysis was performed using the SPSS version 20, IBM. Descriptive statistics were used for analysing the study findings. Paired *t*-test was used for estimating differences between means. Pearson correlation was used to estimate the correlation between the various assessment methods.

RESULTS

Course Details

The summary of the results showed that in the female and male sections (two separated sections), all the students passed, with a high number of students achieving A+ ($\geq 95\%$). The final results of the students are shown in Figures 1 and 2.

Differences Between Mean Scores in the Assessment Methods

We assumed that there was a standardised assessment for midterm and final examinations. The two paper examinations underwent the same process and both contained MCQs, EMQs and short and long essays. They were in equivalent forms. Therefore, there is no bias in the results. As shown in Table 4, there is a significant

increase in the final examinations after implementing the online learning and the electronic examinations. The mean of the students' scores increased by 1.28 in the final compared to the midterm examination for the female students ($n = 73$). Moreover, there was a significant increase in the students' scores in the final examinations in the male section. The mean increased by 1.24 in the final compared to the midterm examination for male students ($n = 42$).

Table 4: Paired samples test (females [$n = 73$]; males [$n = 42$])

Exam per section			Paired differences				t	df	Sig. (2-tailed)	
			Mean	SD	Std. error mean	95% Confidence interval of the difference				
						Lower				Upper
Females	Pair 1	Midterm and final	-1.27856	1.84046	0.21541	-1.70797	-0.84915	-5.935	72	0.000
Males	Pair 1	Midterm and final	-1.23988	1.52513	0.23533	-1.71515	-0.76462	-5.269	41	0.000

Note: Results are expressed as scores of students in the midterm and final examinations in the biology course, data were analysed using a paired t-test.

Correlations Between Different Assessment Methods in the Biology Course

Regarding the correlation between mean scores in the midterm and final examinations as shown in Table 5, the results showed a significant positive in the female section ($r = 0.411$, $p = 0.000$) as well as in the male section ($r = 0.556$, $p = 0.000$).

Results are expressed as students' scores in midterm and final examinations in the biology course and data were analysed using a paired t-test.

As shown in Table 6, there is a significant correlation between quiz 1 (Q1), midterm, final, and final written and OSPE examinations with a positive Pearson correlation of 0.8, 0.4, and 0.6, respectively. This means a good correlation between the theoretical and practical parts of the course, which indicates good evidence of the validity of these online assessment methods. However, the lab manual is only significantly correlated with the final OSPE ($r = 0.4$).

Table 5: Paired samples correlations (females [$n = 73$]; males [$n = 42$])

Section	N	Correlation (r)	p-value
Females Pair 1 Midterm and final	73	0.411	0.000
Males Pair 1 Midterm and final	42	0.556	0.000

Table 6: Correlations between various assessment methods in the biology course ($n = 115$ students)

Assessment method		Correlations					
		Q1	Q2	Midterm	Final	Lab manual	OSPE
Q1	Pearson correlation	1	0.292*	0.810**	0.423**	0.196	0.568**
	Sig. (2-tailed)		0.012	0.000	0.000	0.096	0.000
Q2	Pearson correlation	0.292*	1	0.152	0.176	0.019	0.230
	Sig. (2-tailed)	0.012		0.199	0.137	0.875	0.050
Midterm	Pearson correlation	0.810**	0.152	1	0.411**	0.405**	0.665**
	Sig. (2-tailed)	0.000	0.199		0.000	0.000	0.000
Final	Pearson correlation	0.423**	0.176	0.411**	1	0.097	0.440**
	Sig. (2-tailed)	0.000	0.137	0.000		0.413	0.000
Lab manual	Pearson correlation	0.196	0.019	0.405**	0.097	1	0.437**
	Sig. (2-tailed)	0.096	0.875	0.000	0.413		0.000
OSPE	Pearson correlation	0.568**	0.230	0.665**	0.440**	0.437**	1
	Sig. (2-tailed)	0.000	0.050	0.000	0.000	0.000	

Notes: *Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

With the emergence of the COVID-19 pandemic and the consequent obligatory lockdown, TEL became the only tool to continue the teaching and learning strategy. Many LMS and platforms had been used for this purpose. Blackboard platform version 9.1 (Blackboard, Washington, DC) was one of the efficient tools and, officially, it is the documented LMS in our institution.

In the current study, we aimed to evaluate the learning process during this period (which relied completely on online learning) by comparing students' performance before and during the lockdown. We evaluated the online assessment methods as indicators of students' performance in the biology course.

The current study showed a significant increase in the students' scores in the final examination in comparison to those of

the midterm examination for the biology course. This indicated a higher academic achievement using the online assessment. We had taken into consideration that the performance in the midterm results may be lower than the final results due to the shorter duration of study before the midterm, but this factor alone would not make a significant difference. It is supposed that the students have the same performance in the midterm and final examinations as increasing learning materials and the longer study duration before the final examinations may affect the students' performance, in comparison with the lesser workload and the shorter duration of study before the midterm. Also, there is a significant positive correlation between final examination results with the midterm examination results and other forms of online assessment methods. The high academic score and high achievement of the students that are reported in the current study could be

explained by the free time resulting from the lockdown situation during the COVID-19 pandemic. The free time was the outcome of reduced social time, reduced scheduled classes and the shift to synchronous classes as well as cancelling most of the extracurricular activities. Consequently, students spent more time studying and investing their mental activities and most of them even developed new hobbies. Moreover, most students developed time management skills (12).

In a study by Ahmad Uzir et al. (13), a novel learning analytics methodology which allows for determining self-regulated learning was investigated. The new technique combines learning strategies and time management, which are studied during online learning. The identified tactics and strategies were correlated with academic achievement (13). In addition, in our study, the students were motivated to achieve more in the final examination due to its higher weightage than the midterm examination.

Maintaining the same staff members to deliver the online learning tasks to the same students who started on-site teaching allowed a common delivery of the learning material before and after lockdown, as well as for both male and female students, which lowers the confounding factors resulting from different instructors. Meanwhile, the higher students' attendance rate, reported by the Blackboard and monitored by the instructors were also positive factors. This study has proved that online platforms and learning strategies have the benefits of resolving the problem of lack of physical attendance and increasing learning effectiveness (13).

Also, multiple webinars and orientation lectures about proper online assessment methods were delivered to students at the beginning of the lockdown. This provided the students with more confidence about the assessment methods and made them ready for examinations.

The current study provided evidence of the valuable use of online examinations as successful tools of student assessment during the COVID-19 pandemic lockdown. Online assessments were carried out through the Blackboard platform in our institution as mentioned earlier. The type of assessment methods that were used could help to reflect the nature of online learning as well as give the students more responsibility for their learning (14). Also, the online assessment could allow the students to elucidate their skills in critical thinking regarding the indirect problem-based questions and solving problems in the provided assignment. Also, it gave a key benefit of shifting from traditional teacher-centred learning to student-centred learning where the teacher is mainly a facilitator (15–16). The similar results in female and male sections could be attributed to the fact that there are few differences between male and female students in their use of e-learning and their motivation and satisfaction (17).

The online assessment method in our institution was revised by the e-assessment committee unit of the medical education department, in coordination with the supervisor of the basic medical science department, to estimate enough time for each of the assessment procedures. Objective-based redistribution of students' grades was carried out according to a good structure blueprint that was aligned to CLOs, students learning outcomes and the programme competency-based outcomes. The objective assessment strategies were also kept in consideration. These measures were the causes of the good examination validity and reliability which is reflected in the high student achievement.

One of the main challenges we faced and dealt with was the possible cheating behaviour and unauthorised cooperation between students during the online examination and how to minimise this risk. We followed strict measures during preparation and adjustment of

the examination on the online platform (Blackboard) to deal with this potential problem. These measures included scheduling short-timed examinations with a timer set for the whole examination and each question, random question arrangement and appearance for each student, and the random shuffling of the distractors for each question per student. Students were not allowed to return to the previous question and forced completion of each question was obligatory. The question-answer and feedback were not allowed to appear for students until the end of the examination time and all students had completed submitting all examination answers under permission of the examination moderator. All these regulations made the possible cheating behaviour difficult.

The other challenge we faced was the assessment of psychomotor and practical skills remotely. We used a virtual reality simulator and dry lab procedure to solve this assessment's obstacle after full students' training during the course delivery.

We recommend further training of the faculty on using online learning and assessment methods. The instructors should be trained to develop learning materials with more interactivity and less cognitive load. Thus, students are encouraged to be engaged and participate in various online modalities.

CONCLUSION

From the results of the presented study, we can conclude that online learning through technology-enhanced learning and electronic assessment is a hopeful and promising strategy leading to high and satisfying educational achievement. Online assessment tools have been proved to be successful assessment methods and could provide additional non-traditional methods for students' performance evaluation. With online learning and assessment, students' performance is enhanced. Therefore, it is

recommended to use online assessment methods in addition to traditional methods when returning back to normal after the COVID-19 situation as potential successful assessment tools.

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