

Impact of covid19- Pandemic on Students' Performance in A Problem-Based Learning System: Comparative Study Between Face-to-Face and Virtual Learning

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Abstract

Background: Amongst all other educational institutions, medical schools suffered the consequences of the COVID-19 pandemic. Medical education requires a great deal of interaction between instructors and students, and in the final years, patients as well. In response to the pandemic, the College of Medicine and Medical Sciences at the Arabian Gulf University has applied virtual teaching/learning since March 2020 as an alternative to face-to-face teaching. The college used Moodle and Zoom as online methods for education. The aim of the present study was to evaluate the effectiveness of virtual medical education by comparing students' performance in final exams in face-to-face and virtual settings.

Methods: Following the college's ethical approval, this longitudinal study was performed on 183 medical students. Those students experienced 2 different successive methods of teaching/learning; Unit V as face-to-face followed by Unit VI as virtual settings. Students' performance in theoretical component of the final exams for both units was analyzed and compared.

Results: There was no significant difference in student performance between Units V and VI. Students' performance in the physiology part was equally effective in both units, while the difficulty index of both exams was insignificantly different.

Conclusion: Our results demonstrate that students' performance in final exams could serve as an objective parameter when comparing different educational settings. Our results also support the idea that, in certain aspects, virtual is equal to face-to-face medical education strategies.

Key words: COVID-19, Shift to online learning, Students' academic performance evaluation.

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Introduction

In January 2020, the World Health Organization (WHO) announced worldwide the outbreak of COVID-19, which is a new strain of coronavirus. Two months later, in March 2020, the disease was declared as a pandemic (Liu et al., 2020). COVID-19 has thrown its immense impact on all areas of our life. The field of learning and teaching is of no exception. Schools and universities were compelled to adopt new ways of teaching, as students were unable to come to classes and share the space and place with other colleagues. Almost all educational institutions applied distant or virtual learning, *i.e.*, online learning as a substitute to face-to-face learning.

In response to this unprecedented event, the government of the Kingdom of Bahrain imposed strict and draconian precautions measures to hinder the spread of the coronavirus disease. All educational institutions all over the Kingdom of Bahrain were put on suspension including the regional Arabian Gulf University-College of Medicine and Medical Sciences (AGU-CMMS). AGU is a regional university under the financial support of 6 Arabian Gulf countries, *i.e.*, United Arab Emirates, Kingdom of Bahrain, State of Kuwait, Sultanate of Oman, State of Qatar, and Kingdom of Saudi Arabia. CMMS at AGU adopted the Problem Based Learning (PBL) method for its medical program (Bindayna & Deifalla, 2020; Hamdy et al., 2001). The AGU students are mainly from this region of the world. After the suspension of classroom teaching, AGU students went back to their countries in the hope of returning soon, but governments have issued stay-at-home directives, and it was decreed that students should resume their classes from home by e-learning or what is recently known as virtual or online learning. Hence, virtual classes for medical undergraduate students at AGU were commenced on 21st March 2020, as almost all AGU students have no access to AGU campus or face-to-face learning.

Virtual or online learning has made the process of communication between students and their lecturers easier and more convenient. For the last twenty years distance learning has played a significant role and created a severe competition among universities to expand their scope of teaching (Blouin et al., 2009; Bolliger & Erichsen, 2013; Buchanan et al., 2013; Chapman, 2010). To validate this adoption of online teaching/learning methods, many comparative studies have been carried out to explore whether face-to-face or traditional teaching methods are more productive or whether online learning is better (Lockman & Schirmer, 2020; Pei & Wu, 2019). Results of the studies show that the students perform much better in online learning than in traditional learning.

In medical education, studies have recently been carried out on the impact of COVID-19 on clinical practice (Felder et al., 2013; Tabatabai, 2020), and on how e-learning is a conducive way and an interactive method during the COVID-19 pandemic (Gaber et al., 2020). It is worth to mention that the shift to online learning for the pre-clinical curricula is a pre-COVID phenomenon, and medical students have already been engaged in their medical education while staying at home. Few studies have reported that a greater percentage of pre-clinical medical students relied on online learning instead of attending class, with the majority of students indicating that online lectures are just as effective as or more effective than live class lectures (Ikonne et al., 2018; Lovell & Plantegenest, 2009). However, not many studies have evaluated the COVID- enforced abrupt shift to online learning for medical students in their pre-clinical phase.

As this experience of teaching is a novel method of teaching at AGU, and the shift to virtual online learning was quite abrupt during the pandemic, it was necessary to assess

and examine the outcome of the last six months of online learning at AGU. We determined through this study to evaluate the effectiveness of our enforced virtual teaching-learning strategies on our medical students' performance in final exams at AGU-CMMS amid COVID-19 pandemic, when compared to their performance in a conventional face-to-face teaching-learning environment.

Methods

The Arabian Gulf University - College of Medicine and Medical Sciences (AGU-CMMS) has applied the virtual teaching since March 2020 as an alternative to face-to-face teaching. The university used Moodle and Zoom as an online way of teaching. It is worth mentioning that during the pandemic, our medical students were supplemented with recordings of the lectures for asynchronous learning as a supplement or alternative to real-time attendance, since attendance was not mandatory.

AGU-CMMS medical curriculum consists of three phases, phase I, as year one with basic and fundamental courses in science and English. Phase II, which consists of 9 units: unit I, II and III are taught in year two, units IV, V and VI in year three, and units VII, VIII and IX are given in year four. Each unit contains several cases or disease-scenarios that tackle a specific system, i.e., cardiovascular, respiratory, gastrointestinal, renal... etc. From the weekly cases, students can come up with learning needs or objectives that they are obliged to find the answers for and discuss them with their tutors.

In this study during the academic year 2019-2020, year 3 students took unit V as face-to-face learning. However, after the COVID-19 pandemic, the same group of students were forced to take their resources and lectures for Unit VI online, which provoked our team to carry out a study to compare the students' performance under these two ways of learning.

This is a longitudinal study that attempts to shed some light on the efficiency of AGU experience in online learning for year 3 students. The study is an evaluation of the outcome of online method of teaching as compared to face-to-face traditional learning. The group of students (192 students, 20-22 years old) experienced face-to face teaching from the end of December 2019 to mid-March 2020 studying gastrointestinal and renal concepts and cases (unit V). The same group of students after the outbreak of the pandemic were compelled to take unit VI, concepts and cases of hematology, in an online method of learning.

For each student out of a cohort of 192 students, and for both Unit exams, the number of A-Type multiple choice questions (MCQs) that each student answered correctly was calculated, and then transformed to a percentage of the total number of questions. Data is expressed as mean \pm SD. Kolmogorov-Smirnov test was used to test for normality of data. Statistical tests were selected according to the normality of data.

Results

Unit V (Gastrointestinal and Renal System) was delivered with face-to-face educational methods, while Unit VI (Hematopoietic and Immune System) was conducted remotely online due to the restrictions of the COVID-19 pandemic,

For each student out of a cohort of 183 students, and for both Unit exams, the number of A-Type multiple choice questions (MCQs) that each student answered correctly was

calculated, and then transformed to a percentage of the total number of questions. Data is expressed as mean \pm SD.

For both Units, the data on percentage of MCQs answered correctly (scores) for each student passed the normality test (Kolmogorov-Smirnov test), so parametric analysis was utilized. The score data ranged between 41.3 % to 95.8% for Unit V and 45.8% to 95.8% for Unit VI. The mean MCQ score was $76.0 \pm 10.4\%$ and $75.6 \pm 10.9\%$ for Units V and VI, respectively (Figure 1). A paired t test revealed that the mean MCQ scores were not different between the two Units ($t(182) = 0.66, P = 0.51$). Additionally, Chi-square test of independence revealed no association between Unit and percentage of MCQs answered correctly: $X^2(1, 4) = 5.88, P = 0.21$.

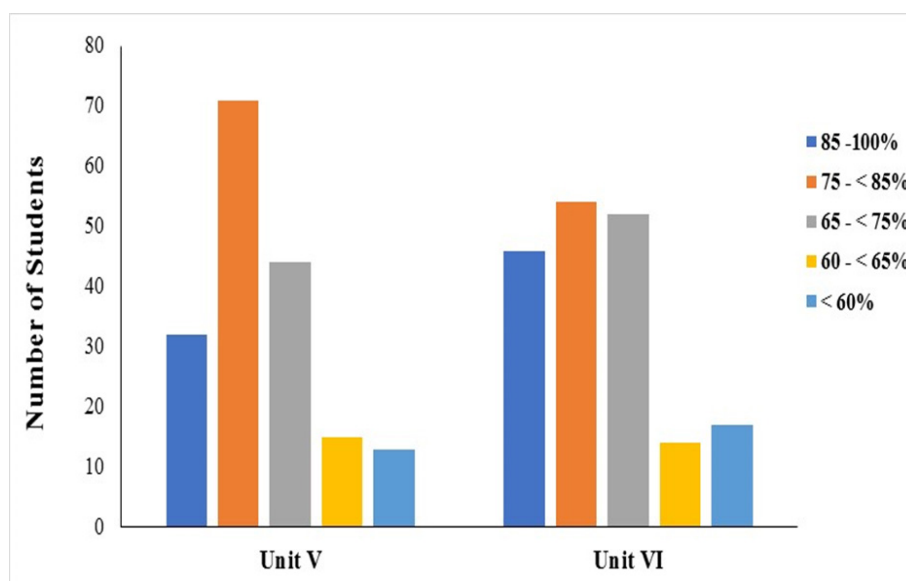


Figure 1. The number of students who answered a certain percentage of MCQs correctly for Units V and VI end-Unit exams. The exam for Unit V was paper based, and teaching was face-to-face. For the same cohort of students, the exam during pandemic academic year (2019-2020) for Unit VI was online, and instruction was also through online distance methods. Chi-square test of independence: $X^2(1, 4) = 5.88, P = 0.21$.

The Physiology component in the end of Unit exam comprised of 21 MCQs in Unit V and 9 MCQs in Unit VI. One Physiology MCQ in Unit V had a negative discrimination index and was discarded from the analysis. The data of scores for correctly answered Physiology MCQs by each student failed the normality test in Unit V. The mean score was $64.9 \pm 13.5\%$ (Range: 28.6 – 95.2 %) and $77.4 \pm 18.4\%$ (Range: 22.2 – 100.0 %) for Units V and VI, respectively. A Wilcoxon Matched-pairs Signed-Ranks Test showed that the median Unit VI score ranks were significantly higher than the median Unit V score ranks ($P < 0.0001$). Chi-square test of independence revealed a strong association between Unit and percentage of MCQs answered correctly: $X^2(1, 4) = 85.45, P < 0.0001$. This is obvious in Figure 2, which reveals that the number of students answering 85 – 100 % of the Physiology MCQs correctly was high ($n = 79/183$ or 43% of the total student cohort).

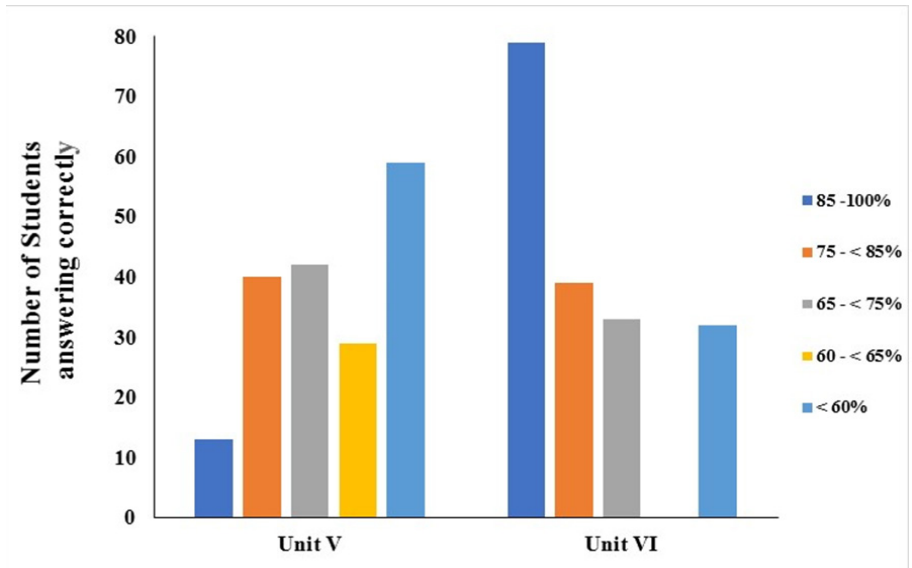


Figure 2. The number of students who answered a certain percentage of Physiology MCQs correctly for Units V and VI end-Unit exams. Units V and VI had 21 and 9 Physiology MCQs respectively. Chi-square test of independence: $\chi^2 (1, 4) = 85.45, P < 0.0001$.

We examined other factors that may have culminated in such a result. We compared mean MCQ difficulty index for Physiology MCQs between the two Units. Difficulty index data passed the normality test for both Units. The mean difficulty index for Unit VI Physiology MCQs was 0.67 ± 0.24 (Range: 0.30 – 0.95) and 0.77 ± 0.14 (Range: 0.58 – 0.97), however unpaired t test analysis revealed no significant difference between the means ($t (27) = 1.09; P = 0.28$). However, Figure 3 shows that for Unit V, there were 7 MCQs (35%) with difficulty index well below the minimum value for Unit VI (value of 0.58).

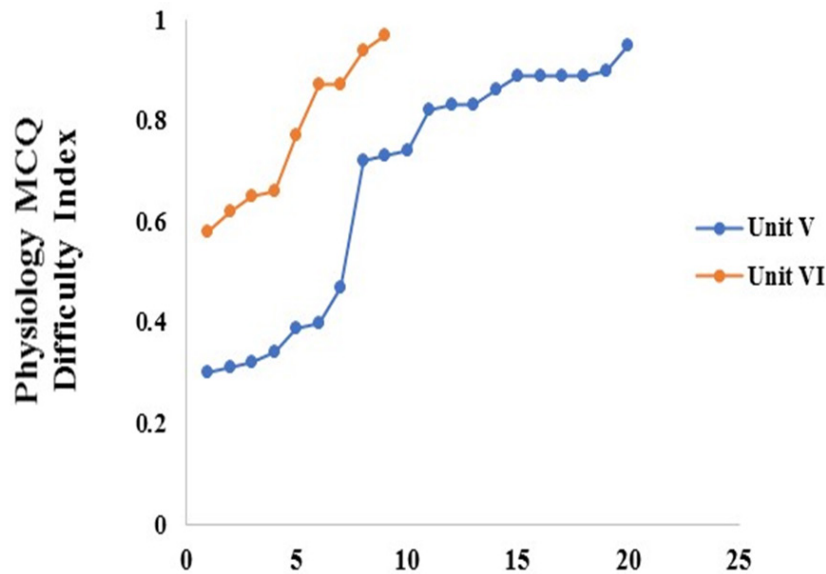


Figure 3. Plot of Physiology MCQ difficulty index data in increasing order for both Units (V and VI).

Discussion

The rapid transition of COVID-19 into a worldwide pandemic has had serious consequences on the higher education institutions with special concerns for the medical schools. The necessity of commitment, discipline, and acquisition of clinical skills underline the challenging nature of medical professionalism. The traditional face-to-face learning format have stood the test of time providing direct interaction with the instructor, commitment to participate, and attention in small group teaching (Ward et al., 2008). The responsibility of the medical schools to follow the advice of the local health authorities, as well as the accountability of the institutions to execute students' assessment and graduation timely, have seriously impacted decisions to promptly adopt online medical education strategies.

In the present study, the same cohort of the 3rd year medical students was followed up during units V (gastrointestinal and renal systems) and VI (hematopoietic and immune systems), with the earlier being delivered face-to-face before the COVID-19-induced shut down of university premises. This provided an almost optimal scenario to compare students' achievement independent of the method of teaching. Our results demonstrated that student's overall performance in both units was not statistically different implying no negative effect of shifting to online teaching strategies even within the same academic year. Our results were in agreement with previously published data which demonstrated that the effectiveness of e-learning in different medical education settings appeared to be as efficient as (Ruiz et al., 2006) or even superior to (George et al., 2014) traditional face-to-face learning approaches. In fact, few studies have reported that there is no apparent association between face-to-face attendance or online learning and academic outcomes in majority of pre-clinical medical courses (Doggrell, 2020; Franklin et al., 2011), especially when online tools are prepared and delivered well.

We focused then on the physiology component in both units for the interest of the physiology department. The overall students' performance in the physiology questions followed the pattern seen in the whole exam; no significant difference was observed between both groups. No doubt that there was fear of the shift from face-to-face to on-line methods, specially that physiology typically deals with mechanisms and interpretations which need proper student-instructor interaction. Previous reports demonstrated the effectiveness of online-physiology teaching methods in mandatory physiology modules when compared to the traditional instructor-dependent methods (Felder et al., 2013). We notice substantial increase in the number of students answering 85-100% of the physiology questions correctly in unit VI when compared to the corresponding value in unit V. To eliminate the possibility of relative easiness of unit VI exam, we compared the difficulty indices of both physiology exam questions which were insignificantly different. We concluded that although there was no statistical difference in student's performance in the physiology component between both units, yet student's performance in unit VI tended to be superior to their performance in unit V, and this was not due to easiness of the unit VI exam.

Our results highlighted an objective parameter denoting the students' performance in the final exam. Most published data comparing traditional to e-learning methods in medical education has focused primarily on students' acceptance, motivation and satisfaction (Felder et al., 2013; Keis et al., 2017; Popovic et al., 2018). However, few reported on the effect of e-learning on the medical students' performance in final exams. Our results not only support the idea that e-learning could be as effective as face-to-face medical

education in the preparation of the students for better performance in final exams, but it also proves that shifting from one method to another even within the same academic year is possible and has no drastic effect on students' performance in final exams. A possible contributing factor to such findings is our medical students' involvement in a PBL setting, in which they are accustomed to self-directed learning and ability to take more responsibility in their learning process (Malan et al., 2014).

Strengths and limitations

Strengths of the study include the evaluating of the same cohort of students in two units with different teaching methods but with the same instructor. The focus on students' performance in the final exam remains an important topic this study challenged.

Limitation of the study include the unequal weight of the physiology component in both units, and therefore the unequal number of physiology questions in each final exam. As such, it would also be interesting to compare in a cross sectional design the performance of two cohorts of students on the same Unit or learning content: one cohort pre-COVID and undergoing face-to-face learning and another post-COVID cohort undergoing distant online learning. Another limitation is that we did not evaluate student satisfaction and perceptions on the effectiveness of the online strategies and tools we adopted for teaching theoretical content of the physiology module.

Conclusion

COVID-19 pandemic raised the necessity to incorporate technology into the medical education process. In fact, without virtual learning facilities, the drastic impact of the global crisis on medical education could have been greater. Our results demonstrated that students' performance in final exams was not different in face-to-face and online environments. This indicates that our online delivery tools were effective for student learning and for their achievement of the intended learning outcomes for the theoretical content in physiology. Unquestionably, a blended system seems to be the inevitable future of medical education, with online teaching methods probably supplementing or replacing face-to-face teaching of theoretical content, and traditional in-person teaching/learning for activities involving psychomotor skills, such as laboratory and Professional skills components of the medical curriculum.

Declarations

Ethics approval and consent to participate

This study was approved by the Research and Ethics Committee of the Faculty of Medicine and Medical Sciences, Arabian Gulf University, Bahrain (E002-PI-10/20). The need for written or verbal consent was waived as deemed unnecessary. All methods were performed in accordance to the regulations and guidelines of the Research and Ethics Committee of the Faculty of Medicine and Medical Sciences, Arabian Gulf University, Bahrain.

Availability of data and materials

All the data supporting findings are presented within the manuscript.

Competing interests

No conflict of interests.

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Authors' contributions

TAA participated in the study design and coordination, reviewed the literature, and drafted the manuscript. YMN participated in the study design, interpreted, and discussed the results. RLA participated in the study design and performed the statistical analysis. FAA participated in the study design and collected the data. All authors read and approved the final version of the manuscript.

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References

- Bindayna, K. M., & Deifalla, A. (2020). The Curriculum at the College of Medicine and Medical Sciences at Arabian Gulf University: A Way Forward to Meet the Future Medical Education Needs. *Journal of Medical Education and Curricular Development*, 7, 2382120520932904. <https://doi.org/10.1177/2382120520932904>
- Blouin, R. A., Riffée, W. H., Robinson, E. T., Beck, D. E., Green, C., Joyner, P. U., Persky, A. M., & Pollack, G. M. (2009). Roles of innovation in education delivery. *American Journal of Pharmaceutical Education*, 73(8), 154-154. <https://doi.org/10.5688/aj7308154>
- Bolliger, D., & Erichsen, E. (2013). Student Satisfaction with Blended and Online Courses Based on Personality Type. *Canadian Journal of Learning and Technology / La revue canadienne de l'apprentissage et de la technologie*, 39(1).
- Buchanan, T., Sainter, P., & Saunders, G. (2013). Factors affecting faculty use of learning technologies: implications for models of technology adoption. *Journal of Computing in Higher Education*, 25(1), 1-11. <https://doi.org/10.1007/s12528-013-9066-6>
- Chapman, T. A. (2010). Evaluation in Distance Education and e-Learning: The Unfolding Model. *American Journal of Pharmaceutical Education*, 74(1), 17a. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2829148/>
- Doggrell SA. **No apparent association between lecture attendance or accessing lecture recordings and academic outcomes in a medical laboratory science course.** *BMC Medical Education* 20: 207, 2020.
- Felder, E., Fauler, M., & Geiler, S. (2013). Introducing e-learning/teaching in a physiology course for medical students: acceptance by students and subjective effect on

learning. *Advances in Physiology Education*, 37(4), 337-342. <https://doi.org/10.1152/advan.00158.2012>

Franklin DS, Gibson JW, Samuel JC, Teeter WA, Clarkson CW. **Use of lecture recordings in medical education.** *Medical Science Educator* 1: 21–29, 2011.

Gaber, D. A., Shehata, M. H., & Amin, H. A. A. (2020). Online team-based learning sessions as interactive methodologies during the pandemic. *Medical Education*, 54(7), 666-667. <https://doi.org/10.1111/medu.14198>

George, P. P., Papachristou, N., Belisario, J. M., Wang, W., Wark, P. A., Cotic, Z., Rasmussen, K., Sluiter, R., Riboli-Sasco, E., Tudor Car, L., Musulanov, E. M., Molina, J. A., Heng, B. H., Zhang, Y., Wheeler, E. L., Al Shorbaji, N., Majeed, A., & Car, J. (2014). Online eLearning for undergraduates in health professions: A systematic review of the impact on knowledge, skills, attitudes and satisfaction. *Journal of global health*, 4(1), 010406-010406. <https://doi.org/10.7189/jogh.04.010406>

Hamdy, H., Grealley, M., Grant, I. N., El-Shazali, H., Nayar, U., Rajab, K., Al-Roomi, K., Mohammad, A. M., Hamza, A. A., Al-Awadhi, M. A., & Al-Refai, A. M. (2001). Professional skills programme in a problem-based learning curriculum: experience at the College of Medicine & Medical Sciences, Arabian Gulf University. *Med Teach*, 23(2), 214-216. <https://doi.org/10.1080/014215901750177604>

Ikonne U, Campbell AM, Whelihan K E, Bay RC, Lewis JH. **Exodus From the classroom: student perceptions, lecture capture technology, and the inception of on-demand preclinical medical education.** *Journal of Osteopathic Medicine* 118 (12): 813-823, 2018.

Keis, O., Grab, C., Schneider, A., & Öchsner, W. (2017). Online or face-to-face instruction? A qualitative study on the electrocardiogram course at the University of Ulm to examine why students choose a particular format. *BMC Medical Education*, 17(1), 194. <https://doi.org/10.1186/s12909-017-1053-6>

Lovell K, Plantegenest G. **Student utilization of digital versions of classroom lectures.** *Medical Science Educator*, 19(1), 2009. <http://www.iamse.org/volume/volume-19-no-1/>.

Lockman, A. S., & Schirmer, B. R. (2020). **Online instruction in higher education: Promising, research-based, and evidence-based practices.** *Journal of Education and e-Learning Research*, 7(2), 130–152.

Liu, Y.-C., Kuo, R.-L., & Shih, S.-R. (2020). COVID-19: The first documented coronavirus pandemic in history. *Biomedical Journal*, 43(4), 328-333. <https://doi.org/10.1016/j.bj.2020.04.007>

Malan SB, Ndlovu M, Engelbrecht P. **Introducing problem-based learning (PBL) into a foundation programme to develop self-directed learning skills.** *South African Journal of Education* 34 (1):457, 2014.

- Pei, L., & Wu, H. (2019). **Does online learning work better than offline learning in undergraduate medical education?** A systematic review and meta-analysis. *Medical Education Online*, 24(1), 1666538.
- Popovic, N., Popovic, T., Dragovic, I. R., & Cmiljanic, O. (2018). A Moodle-based blended learning solution for physiology education in Montenegro: a case study. *Advances in Physiology Education*, 42(1), 111-117. <https://doi.org/10.1152/advan.00155.2017>
- Ruiz, J. G., Mintzer, M. J., & Leipzig, R. M. (2006). The Impact of E-Learning in Medical Education. *Academic Medicine*, 81(3), 207-212. https://journals.lww.com/academicmedicine/Fulltext/2006/03000/The_Impact_of_E_Learning_in_Medical_Education.2.aspx
- Tabatabai, S. (2020). COVID-19 impact and virtual medical education. *Journal of advances in medical education & professionalism*, 8(3), 140-143. <https://doi.org/10.30476/jamp.2020.86070.1213>
- Ward, R., Stevens, C., Brentnall, P., & Briddon, J. (2008). The attitudes of health care staff to information technology: a comprehensive review of the research literature. *Health Information & Libraries Journal*, 25(2), 81-97. <https://doi.org/10.1111/j.1471-1842.2008.00777.x>

مدى تأثير جائحة كوفيد-19 على أداء الطلاب في نظام التعليم القائم على حل المشكلات: دراسة مقارنة بين التعليم الافتراضي والتعليم وجهاً لوجه

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المُستخلص

لقد طبقت كلية الطب والعلوم الطبية بجامعة الخليج العربي نظام التعليم الافتراضي (عن بعد) منذ مارس 2020 كبديل لنظام التعليم وجهاً لوجه. ولقد استخدمت الجامعة نظام موودل وزووم كطريقة التعليم الافتراضي نظراً لانتشار لجائحة كورونا (كوفيد - 19).

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تتناول هذه الدراسة وخلال العام الدراسي 2019-2020 طلبة السنة الثالثة الذين قد اتموا دراستهم للوحدة الدراسية الخامسة من المنهج التعليمي الطبي لمقرر سنة ثالثة بنظام حضور المحاضرات بقاعات الجامعة الدراسية اي التعليم وجهاً لوجه، ولكن وبعد انتشار وباء كوفيد - 19 عالمياً، ولحد من انتشار المرض إحترازياً، فإن نفس الطلبة قد أُلزموا لأخذ الوحدة العلمية السادسة من مقرر السنة الثالثة افتراضياً وذلك للحفاظ على سلامة الطلبة ومنع انتشار الوباء. وهذا هو السبب الذي أدى الى القيام بهذه الدراسة المقارنة لأداء الطلبة باستخدام هاتين الطريقتين التعليميتين.

لقد أظهرت نتائج الدراسة أنه لم يكن هناك أي فرق يذكر في أداء الطلبة بتطبيق أي من طريقتي التعليم في كلا الوجدتين (الخامسة والسادسة). كما أن أداء الطلبة في امتحان جزئية علم وظائف الأعضاء (الفسولوجيا) لم تظهر أي فارق بين نظامي التعليم الافتراضي والتعليم وجهاً لوجه.

مفاتيح الكلمات: كوفيد - 19، التعليم الافتراضي، التعليم عن بعد، الأداء الطلابي، التعليم القائم على حل المشكلات، التعليم وجهاً لوجه.

