

Impact Of E-Learning On Student Engagement And Performance In Clinical Microbiology: A Comparative Study

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ABSTRACT

It is essential for medical undergraduate students to have Clinical Microbiology as a key building block in their studies. Learning about microbiology and using it in practical ways is often hard for students. This study aims to assess how students use the new e-learning tool and what effect this has on their answers in Clinical Microbiology. The new educational material hosted online contributed useful knowledge to the classroom learning in an undergraduate Fundamentals of Clinical Microbiology course. The 2017/2018 group could use e-learning resources apart from the 2016/2017 students who did not use them. The research assigns two types of scores, multiple-choice (MCQ) and short-notes (SNQ), to students in each group after they use the online resource to complete their work. There were two groups in the module, with students from both parallel levels starting together. Over 200 out of the cohort attending in 2017/2018 interacted with the educational material at 80%+ engagement during that period. On average, students devoted more time looking up pathogen information in the index and examining clinical case studies that covered many important clinical microorganisms. The test scores in MCQ and SNQ showed there was an important statistical difference with the 2017/2018 cohort scoring higher than the 2016/2017 group. Average scores for the 2017/2018 students were 5.57% higher than the MCQ exam (95% CI: 3.92 to 7.24%; $P < 0.001$) and 2.08% higher than the SNQ exam (95% CI: 0.74 to 3.41%; $P = 0.02$). Because previous scores were not a big factor, increasing online engagement rate by 1% resulted in an average improvement of 0.05% (between 0.02 and 0.08) on the SNQ exam. According to the research, e-learning improves the chances of students getting better marks in their exams.

KEY WORDS: Clinical Microbiology, E-learning, Examination performance

INTRODUCTION

Medical students are taught Clinical Microbiology as a main part of their curriculum based on [1]. Undergraduate medical students should learn bacteriology, virology, mycology, infection pathogenesis, how to test for infections in the laboratory, pharmacology, antimicrobial therapy and stewardship, public health, epidemiology, infection prevention and control and preventive interventions, as Clinical Microbiology covers several areas in biomedical sciences and pathology. Nearly all pre-clinical medical students in the United States receive education about microbes from 104 medical curriculum programs, often in separate courses or as bundles [1]. Students begin by learning microbiology fundamentals from the curriculum and then use them in cases where imprecise details are revealed in daily care of patients. Most of these modules combine lectures, tutorial sessions and the usual classroom-based instruction [1]. Because Clinical Microbiology introduction courses involve a large body of information, students find it tough to grasp the subject properly at the beginning [2, 3]. Concepts from biomedical science often seem difficult for students to use in a clinical context. Long lectures without active clinical examples and an overdependent use of them can separate important subjects and result in losing the main concepts [4]. In our view, students fail to realize the relevance of microbiology principles for clinical applications. Most students understand the existence of *Staphylococcus aureus* toxins, but rarely connect those toxins to how infections happen and their corresponding symptoms. Healthcare training now uses Technology-enhanced learning (TEL) as well as e-learning, both of which appeal to students with the right electronic devices [5, 6]. The system helps students to study whenever they want, deciding for themselves how fast to learn. Using beneficial online resources allows students to examine their own knowledge and identify where they lack understanding, as feedback is provided. E-learning units should be monitored and evaluated all the time, as noted in Ferguson et al. [7]. Some educators in medicine point out that we need to pay special attention during e-learning because it could replace clinical hands-on courses [8]. Researchers are not in agreement about how much online learning improves memory and test results. During 2017, an additional online website was added to improve the learning of Clinical Microbiology as taught to second-year undergraduate medical students at the Royal College of Surgeons in Ireland. In an integrated approach, the course showed students how microbial ideas could be used in medical situations.

The purpose of the research was to determine how involved students were in online classes during the course and what exam outcomes they achieved.

METHODS

Study design, student population and ethical approval

In this study, we aimed to study a newly introduced online educational strategy by using a comparative method to look at examination results. Second-year medical students at the Royal College of Surgeons in Ireland (RCSI) were the subjects for the study in 2016 and 2017. In 2016/2017 there were 329 students learning at the school, compared to 2017/2018 which had 334. The study included all 329 students (93.7%) from 2016/2017 and all 334 students (92.5%) from 2017/2018, who completed the end-of-semester exam to qualify for the study. Under approval, the RCSI Research Ethics Committee allowed researchers to access student exam results for the research study. The school didn't ask students if it was okay to release their exam data to researchers.

Module structure

The first week of the second year's second semester is when FIM is offered, lasts 5 weeks and is worth 10 ECTS credits. There are 29 lectures and four tutorials on this subject, each covering the essentials of 14 bacterial genera, four families of viruses and core fungi that commonly infect people. Besides, students learn key aspects of saboşu ve tenelmek bakanlıkları, antimicrobial medications, vaccinations and keeping infections at bay. Learning objectives for this module are as follows:

- Identify the characteristics of major groups of medically relevant bacteria, viruses, fungi, and other microorganisms
- Relate the basic physiological and molecular traits of these microbes to clinical practice
- Explain the mechanisms by which microbes cause infection and disease, including pathogenicity and transmission
- Recognize the features of common pathogens
- Apply fundamental principles of antibiotic therapy and use antibiotics appropriately
- Implement infection prevention measures, such as vaccination and hand hygiene
- Apply laboratory diagnostic principles and utilize the laboratory effectively

Content design

All the learning objectives from the upcoming module were explored further through the educational content on the website. Essential topics in Clinical Microbiology were covered with an alphabetic glossary supported by interactive questions. As well as using an A-Z glossary, students could try several interactive question-and-answer exercises about cell morphology, prokaryotic cell structure, microbial growth and physiology, bacterial genetics, virology, mycology and infection pathogenesis. The program supplied podcasts full of multiple-choice quizzes on complicated Clinical Microbiology topics as well as helpful question-and-answer sessions for important anti-microbial terms (Table 1). The workshop's microbe experts designed informative cases on important microorganisms and held quizzes afterward, offering answers and explanations focused on how viruses spread and are diagnosed in hospitals (see Fig. 1). Clicking on a pathogen name led to an individually sortable page with details about epidemiology, virulence, infection, diagnosis in the lab, treatment and prevention. Already, the course contained special modules aimed at important pathogens and among them was influenza. Students were taught both their academic year requirements and the exact rules for the introductory sessions from the Marks and Standards document in the in-person session that reviewed the module. All parts of the online course were necessary for students to do, though they did not receive any penalty for not finishing everything. By using Moodle, students could access online lessons as well as see how their activity and work completion compared with other students in the system.

RESULTS

Table 1: List of Online Activities under Key Concepts, Podcasts, and Antibiotics

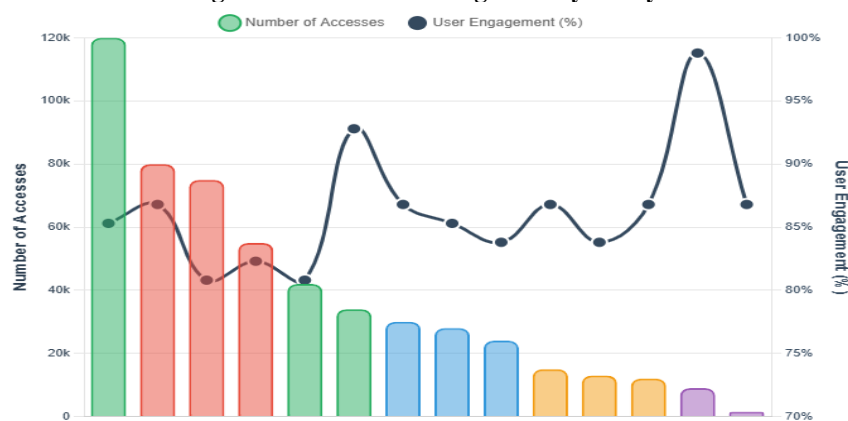
Activity Title
Core Concepts
Microorganism Categorization
Bacterial Structure & Cellular Composition
Bacterial Proliferation & Physiology
Mechanisms of Bacterial Infection
Introduction to Virological Science
Introduction to Fungal Pathogens
Correct Utilization of the Microbiology Diagnostic Lab

Introduction to Infections Acquired in Healthcare Settings
Introduction to Opportunistic Pathogens

Table 2: The Most Accessed Online Activities under Each Individual Subject

Online Activity	No. of Times Accessed	No. of Individual Users/Registered Users (%)
Core Concepts		
Bacterial Morphology & Cell Structure	80,000	290/334 (86.8)
HCAIs & Infection Prevention & Control	75,000	270/334 (80.8)
Bacterial Genetics	55,000	275/334 (82.3)
Podcasts		
HCAIs	15,000	290/334 (86.8)
Aminoglycosides, Quinolones & Macrolides	13,000	280/334 (83.8)
Streptococci	12,000	290/334 (86.8)
Antibiotics		
Important Resistant Bacteria	120,000	285/334 (85.2)
Adverse Effects of Antibiotics	42,000	270/334 (80.8)
Classification of Antibiotics	34,000	310/334 (92.8)
Pathogen Focused Online Cases		
Herpes Virus Infections (Herpes Simplex & Varicella Zoster)	30,000	290/334 (86.8)
Streptococcus spp.: A 68-Year-Old Male with CAP	28,000	285/334 (85.2)
Streptococcus spp.: A 7-Year-Old Female with Pharyngitis	24,000	280/334 (83.8)
Pathogen Index	9,000	330/334 (98.8)
Glossary of Terms	1,500	290/334 (86.8)

Figure 1: Online Learning Activity Analysis



The most accessed online activities for second-year medical students in Clinical Microbiology are listed in Table 2, covering Core Concepts, Podcasts, Antibiotics, Pathogen-Focused Online Cases, Pathogen Index and Glossary of Terms. Under Core Concepts, Bacterial Morphology & Cell Structure was the activity students used the most, being accessed 80,000 times. Next were HCAIs & Infection Prevention & Control with 75,000 accesses and Bacterial Genetics with 55,000. The keen interest in these main concepts means that students are concentrating on important microbiology topics for infection knowledge. Data from the Podcasts section show that interest in HCAIs was highest with 15,000 accesses and many also watched videos about Streptococci, Aminoglycosides, Quinolones and Macrolides. On the topic of Antibiotics, the subject that got the most reviews was Important Resistant Bacteria, with 120,000 hits, then Adverse Effects of Antibiotics (42,000 hits) and lastly Classification of Antibiotics (34,000 hits). By doing this, we highlight the students emphasizing antibiotic resistance and learning about using antibiotics in clinical practice. Herpes Virus Infections (30,000 accesses) drew more interest than Streptococcus spp., according to the Pathogen-Focused Online Cases. An elderly male presenting with CAP who was found to have Streptococcus spp. (28,000 accesses) A 7-Year-Old Female with Pharyngitis (24,000 accesses) which may mean that students are drawn to learning from case

examples. The Pathogen Index and the Glossary of Terms were the two resources most accessed and the Pathogen Index gained 9,000 accesses, proving it to be a trusted and practical guidebook for students.

DISCUSSION

About 70% of the students explored more than 80% of the content on the new online website. Analysis of the data suggests that with greater use of online materials, the 2017/2018 cohort fared far better in their final semester exams, especially in the SNQ section. It has become clear that e-learning supports and improves the achievement of learning goals in healthcare education. A study that combined learning at school with online study recently found that nurses' clinical skills got better [9]. A different study on e-learning found that on average, 3.6% of participants did better on the immunology questions of the examination, thanks to their involvement with online resources [10]. Analysis of the numbers revealed an improvement in SNQ scores among patients who were highly active online, but no connection between online participation and MCQ scores was discovered. They work well to validate learning when they are designed properly, as is common in our courses. Still, MCQs place less emphasis on understanding topics and can cause students trouble when the difference in an answer is only minor. Students may prepare for content-heavy MCQs with a simple strategy and this approach has been related to worse grades [11]. Some continue to discuss which type of assessment is better: MCQs or SNQs in healthcare education. Yet, recent studies report that they are both effective in assessing complicated abilities, so long as the MCQs are well planned [12]. Engagement in the pathogen-focused online cases was good, with students especially interested in topics that discussed herpes viruses and streptococci. It is understandable that this information was the most popular for students because of the clinical relevance of the pathogens and the large variety of symptoms they can cause. Putting infections into context allows medical students to understand the different stages, the part the pathogen plays, how the disease is identified in labs and clinics and how to manage patients. Most recent educational programs use integrated and blend activities to bring students together, giving them the proper knowledge to address different clinical cases and serving different learning needs. Using case-based learning (CBL) for healthcare teaching is a well-known and appreciated way, whether it is carried out physically or online [16, 17]. Microbiology and infections education is now increasingly using technology and online resources and these now include audience response devices, videos, online case studies, virtual patients and gaming [5, 6, 18]. The result of the study showed that more engagement with online learning was linked to improved exam performance, but it was not possible to explain the connection between engagement and how well students did in related MCQ or SNQ questions. In addition, because no demographic information was collected, it wasn't possible to detect any additional influences on student engagement. The study included only one year's worth of data after the online content began. It is particularly useful that the cohorts were directly compared by testing exam performance. Because both groups had the same exams every year, a third cohort wasn't included so that the assessment process wouldn't face threats from students finding similar questions. Although it is possible that students from the 2016/2017 group told details of the assessment to the next group, at this time, we do not have evidence this actually happened. Besides, our procedure for creating exams maintains the integrity of the papers and makes certain students cannot use past exams to help them predict future topics. As a result, we think there would be close to zero impact from the 2016/2017 cohort on the 2017/2018 cohort. Accepting multiple ways of learning helps every child get the most out of their studies. Healthcare education is now relying more on TEL because it promotes a student-led approach and supports better designed lessons for greater student involvement [19]. A number of studies have investigated using TEL in healthcare, noticing improvements in the learning of students [20–23]. Students mostly accept new learning techniques, including using the internet for classes, but it is sometimes hard to measure their influence on learning. Results from one study show that e-modules did not improve the results of medical students on the National Board of Medical Examiners paediatric exams [20].

CONCLUSION

We found that e-learning in Clinical Microbiology resulted in positive feedback and a boost to student scores on exams. Training in clinically connected pathogens, laboratory testing and antibiotic therapy should be included in basic medical science teaching because they are often tough topics for students to grasp. A research study carried out not long ago proved that using online educational tools can help medical students perform better when prescribing under exam circumstances [25]. Because health professional courses are now more grouped, active discussions about Clinical Microbiology are expected to occur since this subject is high in content, aiming to ease the workload for students and deliver better experience. When applied properly, TEL can guarantee that this critical topic is always covered in updated study programs so students can learn well and ace the connected assessments.

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