

2021-08-19

# Using alternative teaching and learning approaches to deliver clinical microbiology during the COVID19 pandemic

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<http://hdl.handle.net/10026.1/17383>

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10.1093/femsle/fnab103

FEMS Microbiology Letters

Oxford University Press (OUP)

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1 **'Using alternative teaching and learning approaches to deliver clinical microbiology**  
2 **during the COVID19 pandemic** Lovleen Tina Joshi<sup>1\*</sup>

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6 **Abstract:** The COVID19 pandemic has had significant impacts upon Higher Education  
7 teaching. Clinical microbiology teaching is primarily focused on a combination of practical skills  
8 development alongside didactic delivery of content. In the pandemic the absence of in person  
9 teaching has led to educators adapting in person content for online platforms and delivery.  
10 This commentary covers alternative innovative and engaging teaching approaches to deliver  
11 clinical microbiology content during the COVID19 pandemic.

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13 **KEYWORDS: Clinical Microbiology, teaching, engagement, online, in-person**  
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33 **Introduction:** Severe acute respiratory syndrome coronavirus 2 (SARS CoV-2), causative  
34 agent of COVID19 disease, has had unprecedented global health, economical and societal  
35 impacts (Mou, 2020; Wu et al., 2020). SARS-CoV-2 is a respiratory viral pathogen able to  
36 readily transmit between infected individuals via droplet or airborne transmission (Morawska  
37 and Milton, 2020; Prather et al., 2020). As SARS-CoV 2 spread uncontrollably across the  
38 globe, pressure across healthcare services grew as hospital admissions and mortality rates  
39 increased (Lee et al., 2020). On 11th March 2020 the World Health Organisation (WHO)  
40 declared COVID19 as a pandemic and on 23<sup>rd</sup> March 2020 the UK Government declared a  
41 national “Lockdown” where “stay at home” measures, including social distancing, were  
42 implemented to protect UK citizens and preserve National Health Service (NHS) healthcare  
43 capacity (Lee and Morling, 2020).

44 The consequences of “stay at home” lockdown measures were unprecedented for Higher  
45 Education (HE) Teaching. Prior to the pandemic, some HE institutions had provisions for  
46 instant accessible learning via the use of digital lecture content capture platforms to enhance  
47 the student experience (Biggs and Tang 2011; Newton et al., 2014). There are arguments that  
48 this has been primarily driven, in the UK, by increased student expectations in the face of  
49 paying tuition fees i.e. where students are perceived as the “consumer” and HE institutes as  
50 “service providers” (Myers, 2013; Wong and Chiu, 2019). However, when the pandemic hit,  
51 online transition was forced upon HE institutions causing a complete shift from in-person  
52 delivery of education to online teaching (Lemay et al., 2021). In such difficult circumstances,  
53 how is it possible for lecturers to successfully engage and motivate students?

#### 54 **Adapting to Online Teaching**

55 Clinical microbiology is the diagnostic study of infectious microorganisms and their role in  
56 human disease (Reller et al., 2001). Effective teaching and learning of clinical microbiology  
57 relies on a combination of “hands on” practical active learning techniques alongside didactic  
58 delivery of essential scientific information, with the latter being encouraged due to its perceived  
59 “economical and efficient” delivery to large student cohorts (Rutherford, 2015; Stevens et al.,

60 2017). Didactic lectures tend to use a combination of both behaviourist and constructivist  
61 learning approaches resulting in passive student learning (Keough & Naylor, 1996). Thus  
62 motivating students to engage with STEM (science, technology, engineering and  
63 mathematics) subjects via didactic delivery in a teacher-centred approach is not necessarily  
64 conducive to successful student learning. To mitigate potential lack of student engagement,  
65 HE lecturers often combine traditional teaching techniques with small group teaching, flipped  
66 classroom techniques, gamification and quizzes (Ashwin et al., 2015).

67 Face-to-face teaching also allows educators to tailor to individual needs in real time and  
68 answer queries directly for the student in a student-centred approach, especially in a practical  
69 laboratory context (Tofade et al., 2013). In the case of teaching, employing a constructivist  
70 approach via active learning can enable students to teach each other through understanding  
71 and building upon frameworks of microbiological knowledge (Piaget, 1970; Hunt & Chalmers,  
72 2013). During the pandemic, the transition from teaching face-to-face to online posed a  
73 challenge when attempting to engage students and encourage active learning (Table 1).

74 During a pandemic, it is likely easier for microbiology concepts to be put into immediate and  
75 relevant context. An example of this of this is in teaching epidemiology, for example outlining  
76 John Snow's use of the Scientific Method in investigating the 1854 Cholera outbreak in Soho,  
77 and relating this back to the current SARS-CoV-2 epidemiological investigations (Caplan et  
78 al., 2020). Impacts of asymptomatic transmission, especially in the current context of SARS-  
79 CoV-2, can be explained by using the example of "Typhoid Mary" as an asymptomatic  
80 transmitter of *Salmonella typhi* (Brooks, 1996; Marineli et al., 2013). Employing case study  
81 and infection scenarios online is also possible through use of collaborative learning; where  
82 students can be put into breakout rooms to examine the scenarios and feedback to the cohort  
83 (Rutherford, 2015).

84 Another way of making online content more interesting for clinical microbiology students is to  
85 relate the content to popular culture via investigative case studies (Tomes, 2002). An example  
86 of this is adapting scenarios from the reality television programme Love Island to hypothetically

87 map transmission of Sexually Transmitted Infections (STIs) and explain symptoms among the  
88 contestants. Love Island is a reality-based television dating programme where “single”  
89 contestants spend two months in a villa in Spain to find a partner. On arrival, contestants are  
90 asked to pair up with a partner i.e. “coupling up” and anyone left “single” has to leave the  
91 programme (L'Hoiry, 2019). The contestants take part in challenges in their “couples”, kiss,  
92 and can choose to become more intimate in the “Hideaway”. The infection case study scenario  
93 is adapted from this where fictional contestants can “couple up” and be given a hypothetical  
94 STI (or not). Students can in groups, using a trail of informative symptomatic clues given in a  
95 document via breakout rooms, figure out who originally had the “STI” from the love  
96 connections made. The final assessment of student understanding is to explain the results of  
97 a PCR (polymerase chain reaction) test to determine which antibiotic resistant “superbug” the  
98 contestant had (one such scenario used *Neisseria gonorrhoeae* as the STI). This adapted  
99 learning scenario was successfully tried in practice as (i) students enjoyed the investigative  
100 nature of the learning and (ii) the programme is already popular with Generation Z students.  
101 Generation Z are defined as being born post 1995, have yet to enter the workforce and are  
102 digitally savvy, highly connected and make fast decisions (Cilliers, 2017; Dimock, 2019).

103 Gamification, where game techniques are applied in a non-game environments, is being  
104 increasingly used within HE as an attractive substitute for didactic learning (Plass et al., 2015;  
105 Efthimiou and Tucker, 2021). Gamification allows students to engage with “drier” teaching  
106 content and is thought to increase student retention of learning material (Robinson et al.,  
107 2018). While it is easy to undertake gamification activities using physical board games in small  
108 group teaching scenarios, it is also possible online. One such way is by playing games such  
109 as “STI Bingo” online with students over zoom, where symptoms of STIs (Sexually Transmitted  
110 Infections) can be called out by the educator as per the game’s instructions, and when the  
111 student has crossed off a full set of symptoms on their card, they can shout out what STI they  
112 potentially have (BPAS, 2021). Another way of employing gamification online is by use of  
113 applications (apps) on mobile phones or computers which are cheaper alternatives to physical

114 materials when teaching large cohorts. Examples of this include “Outbreak” and the Plague  
115 Inc games app (Ndemic Creations, UK) that can be played on various platforms such as  
116 mobile phones and can engage students with learning about the effects of pathogens with  
117 specified traits on a population (Robinson et al., 2018; de Almeida, et al., 2021).

118 Tapping into academic networks to find guest lecturers on a relevant topic is also a good way  
119 of increasing student engagement. High profile speakers who have been involved in the  
120 pandemic can be asked to deliver real life information to students which increases their  
121 interaction, enthusiasm and understanding of the relevance of “drier” taught content (Fahnert,  
122 2016). One such example was asking a contact who specialised in COVID19 research within  
123 Public Health England to deliver a guest lecture online. The students were inspired by this  
124 lecture which covered the most recent developments in the pandemic. The guest lecturer was  
125 secured in advance of the lecture due to being in high demand. One of the key benefits of  
126 having guest lectures online is the reduced need for travel, more efficient use of time and the  
127 fact that these lectures remain recorded for students to refer to anytime.

128 Of course, other methods to engage students online include using props, such as Giant  
129 Microbes™ to show students pathogenic characteristics of microorganisms in a crude but safe  
130 and fun format (Jermy, 2016). Giant Microbes are plush toys of microbes that can be used as  
131 gifts or educational aids for adults and children. They come in a range of microorganisms from  
132 bacteria such as *Vibrio cholerae* to viruses such as Ebola and SARS-CoV-2. Giant Microbes  
133 are a highly effective way of teaching some basic clinical microbiology to students without the  
134 use of a laboratory. For example, when teaching students online about a certain  
135 microorganism, such as SARS-CoV-2, the Giant Microbe plush toy can be shown to students  
136 online to demonstrate its key features such as “spikes”. The same can be said for the use of  
137 real time sequencers- such as the Oxford Nanopore™ Minion sequencer that can be safely  
138 and successfully used to demonstrate DNA sequencing in real time online or in person  
139 (Salazar et al., 2020).

140 Practical laboratories in clinical microbiology are essential learning environments for students  
141 to obtain hands on practical skills and develop professionally. This experiential learning is not  
142 possible through didactic lectures; however, during the pandemic alternatives needed to be  
143 sought in the absence of in-person clinical microbiology teaching. The skill sets required  
144 include safe working practices, the ability to utilise aseptic techniques and handle  
145 microorganisms (Noel et al., 2020). Attempts to substitute in-person learning include use of  
146 videos to demonstrate key techniques within the laboratory, where the educator is filmed  
147 demonstrating tailored microbiological techniques, such a streaking an agar plate. While this  
148 is no substitute for hands on learning, students can be encouraged to safely practice some  
149 techniques at home using everyday items. For example, the streak techniques can be  
150 practiced at home using jelly set in a bowl and a piece of blunt plastic cutlery to streak  
151 chocolate sauce in the usual streaking format; the idea being that students can ensure the  
152 jelly is not broken when streaking (Madigan et al., 2017). In the case of the educator not being  
153 able to physically record the techniques, the Journal of Visualized Experiments (JoVE) has a  
154 repository of videos, but does require a subscription. Of course, not all techniques can be  
155 practiced in this way, and hence there is a potential role for use of virtual online laboratories  
156 in the pandemic. An example of this is Labster™ which provides laboratory simulations at a  
157 subscription cost (Alvarez, 2021). However, considering the core traditional microbiology skill  
158 set required by future microbiologists, online learning is a poor substitute for in-person learning  
159 where immediate, tailored feedback can be given to students.

160 In the author's case it was possible to deliver microbiology practicals during the semester by  
161 provisioning extra practical sessions which allowed us to stay safe from COVID19 and adhere  
162 to government social distancing guidelines. For those unable to deliver during semester  
163 planned summer laboratory "catch up" classes are an excellent way of addressing the lack of  
164 in-person laboratory learning. One concern, however, is how many students do attend these  
165 additional classes over the summer period.

166 **Summary:** It is likely that online teaching will continue in some format while the COVID19  
167 pandemic continues. An ideal scenario would be blended learning where successful elements  
168 of online teaching are combined with in-person teaching to deliver an appealing student  
169 experience (Sancho et al., 2006). As a microbiology educator, I did try many of the above  
170 techniques to improve student engagement and information retention. My lectures were  
171 didactic but used Giant Microbes to demonstrate key microbiological features, and securing a  
172 guest lecturer from Public Health England microbiology enhanced the new SARS-CoV-2  
173 content I had incorporated into the module. I delivered workshops via breakout rooms where  
174 students could collaboratively work on infection case study scenarios, such as STIs and  
175 general clinical cases. The feedback from these alternative approaches was overwhelmingly  
176 positive. Moreover, covering the background of epidemiology starting with Jon Snow and the  
177 Scientific Method through to current epidemiological methods to investigate outbreaks  
178 improved the students' understanding of the current pandemic. In fact, the epidemiological  
179 steps in outbreak investigations formed part of the students' examination assessment in June  
180 2021. I also employed gamification by playing STI Bingo with the students online which  
181 consolidated their understanding of clinical symptoms of STIs. These sessions are not only  
182 engaging for the students but can be great fun for the lecturer too. Indeed, a future clinical  
183 microbiology course is likely to be blended in format, combining online platforms for guest  
184 lectures, gamification, online quizzes and face to face didactic and practical sessions to  
185 enhance microbiology learning. This will require constant modification and trialling of  
186 alternative approaches to see which work best across cohorts.

187 Allowing students to communicate and feedback within online sessions is key to increasing  
188 engagement and a sense of being part of the learning community (Figure 1). This is not true,  
189 however, for clinical microbiology laboratory skills which do require in-person teaching. This  
190 is essential to train the microbiologists of the future to safely handle clinical pathogens without  
191 compromising their professional development. Therefore delivering extra practicals during  
192 semester was the best way we ensured that the student experience would not be  
193 compromised and that they would acquire essential skills required for the course- especially if

194 accredited. The COVID19 pandemic appears to have encouraged a renewed interest in the  
195 study of clinical microbiology. I have experienced an increase in students (84 in 2020)  
196 choosing to undertake the clinical microbiology module at final year compared to previous  
197 years (50 in 2019). From reading student feedback the main drivers for this increase is a desire  
198 to learn more about AntiMicrobial Resistance, COVID19 disease and microbiology. Engaging  
199 and innovative teaching has a significant and important role to play in providing microbiologists  
200 with the skills to tackle healthcare challenges, especially with the advent of the COVID19  
201 pandemic and the silent pandemic of AntiMicrobial Resistance.

202

### 203 **Acknowledgements:**

204 The author wishes to express her sincere thanks to the students she has taught to date. A  
205 special mention to current students who have achieved their degree qualifications despite the  
206 turbulence of the COVID19 pandemic. No funding was used to produce this commentary.

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