

## Development and evaluation of a novel massive open online course in travel medicine for undergraduate healthcare students

Gerard Thomas Flaherty<sup>1,2</sup>, Lydia Sze Teng Lee<sup>2</sup>, Aida Lina Alias<sup>3</sup>, Hasnain Zafar Baloch<sup>3</sup>, Bryan Chang Wei Lim<sup>1,2,4</sup>, Kok Leong Tan<sup>5</sup>, Victor Lim<sup>6</sup>, Lokman Hakim Sulaiman<sup>5,7</sup>

### Abstract

**Introduction:** Massive open online courses (MOOCs) are designed to accommodate large numbers of geographically dispersed learners. Few healthcare students receive exposure in travel medicine. We aimed as partner medical universities to develop a novel introductory MOOC in travel medicine suitable for undergraduate healthcare students, and to evaluate it among a cohort of learners.

**Methods:** A course development team, comprising a senior travel medicine academic from National University of Ireland Galway, local International Medical University faculty and instructional/graphic designers, was convened in November 2017. The MOOC proposal was subsequently refined. Course construction commenced in December 2017 and involved communication between team members based in Malaysia and Ireland. Lectures were recorded in January-July 2018. Development of learning and assessment material and the pilot phase were completed in December 2019. Course evaluation was based on the results of a questionnaire and qualitative free text comments from users.

**Results:** The MOOC is being delivered to a multinational cohort on a rolling basis. It is organised into five four-themed units: travel health risk assessment; pre-travel health advice; tropical infectious diseases; specialised travellers; and illness in returned travellers. Pedagogical methods include short video lectures, journal articles, a discussion forum, and self-assessment quizzes. Learners have the option of completing an online test to receive a certificate of achievement. Participant evaluation from the first run of the MOOC has revealed very high levels of satisfaction with content and mode of delivery.

**Conclusions:** This is the first MOOC in travel medicine and it may provide a model for development of other collaborative international e-learning courses. It will address a significant deficit in undergraduate health professional education.

**Keywords:** *Travel medicine, global health, MOOC, medical education, e-learning.*

### Introduction

Travel medicine has established itself as a legitimate medical discipline since its origins in the 1970s, some thirty years after the first publication of academic literature relating to medical fitness to fly.<sup>1</sup> Although it has achieved limited specialty recognition to date<sup>2</sup>, travel medicine (emporiatics) is practised in most developed countries by physicians, often with an infectious disease, public health or general practice background, by travel health nurses and, in some jurisdictions, by community pharmacists. The International Society of Travel Medicine (ISTM), established in 1991, now has nearly 4,000 members in over 100 countries worldwide. The content-rich biennial Conference of the ISTM (CISTM)<sup>3</sup> typically hosts over 1,500 delegates. The ISTM, through its professional education committee, provides a diverse array of educational opportunities to its members in the form of webinars, review courses and online learning resources.<sup>4</sup>

Although relatively poorly funded, travel medicine has become a fertile field of research activity, with four specialist journals publishing original and review articles in the discipline. A citation analysis of travel medicine literature has characterised the most influential publications in the field.<sup>5</sup> Two travel medicine journals have published comprehensive bibliometric analyses

<sup>1</sup>School of Medicine, National University of Ireland Galway, Galway, Ireland

<sup>2</sup>School of Medicine, International Medical University, Kuala Lumpur, Malaysia

<sup>3</sup>Department of Learning Resources, International Medical University, Kuala Lumpur, Malaysia

<sup>4</sup>Department of Emergency Medicine, Mercy University Hospital, Cork, Ireland

<sup>5</sup>Department of Community Medicine, School of Medicine, International Medical University, Kuala Lumpur, Malaysia

<sup>6</sup>Department of Pathology, International Medical University, Kuala Lumpur, Malaysia

<sup>7</sup>Institute for Research, Development and Innovation, International Medical University, Kuala Lumpur, Malaysia

#### Address for Correspondence:

Prof Gerard Thomas Flaherty, MD School of Medicine, National University of Ireland Galway, Galway, Ireland. Email: gerard.flaherty@nuigalway.ie.

of their publications<sup>6,7</sup>, which have reflected the broad scope of travel medicine practice and scholarship, as well as identifying gaps in research output. Beyond the ISTM, much of travel medicine education is delivered by national and regional travel medicine societies, such as the Travel Medicine Society of Ireland and Asia-Pacific Travel Health Society.

A limited number of postgraduate educational programmes leading to post-nominal credentials in travel medicine currently exist. The ISTM body of knowledge describes the domains and sub-domains of activity within travel medicine.<sup>8</sup> The Certificate in Travel Health examination offered by the ISTM is based on the ISTM body of knowledge and it recognises excellence in knowledge of travel medicine. It must be renewed on a ten-yearly basis, unless the holder can demonstrate significant ongoing education in travel medicine. Deficiencies in travel medicine education and training exist at the level of primary care, where general practitioners and practice nurses may be called upon to prepare international travellers medically without having received any formal education in the area. Apart from isolated examples of travel medicine-related student selected components as part of innovative university curricula<sup>9</sup>, travel medicine is almost entirely absent from undergraduate medical, pharmacy and nursing programmes. The current COVID-19 pandemic has reminded the academic community of the importance of global biosecurity and traveller behaviour in mitigating the spread of communicable diseases. Prior to the pandemic, international travel had reached impressive levels, with projected increases in passenger arrivals to 1.8 billion by 2030.<sup>10</sup> If the expansion of travel volumes in emerging economies within Asia, the Middle East and Africa<sup>11</sup> recovers in a post-COVID era, travel medicine

education will assume even greater significance in developing countries.

The accelerated uptake of online instruction and assessment in the higher education sector during the current pandemic has brought technology-enhanced learning pedagogies into sharper focus. One of the more recent disruptive innovations in online learning has been the Massive Open Online Course (MOOC) which is regarded as a product of the Open Educational Resources movement.<sup>12</sup> A MOOC has been defined as “an online course with the option of free and open registration, a publicly shared curriculum, and open-ended outcomes”.<sup>13</sup> MOOCs offered by reputable educational institutions provide valuable access to reliable information without the limitations imposed by time, geographical considerations, or educational level. The first American MOOCs were offered by Stanford University in 2011<sup>14</sup>, three years after the University of Manitoba launched their course ‘Connectivism and Connective Knowledge’<sup>15</sup>, which is believed to be the world’s first MOOC. Since then, many of the world’s leading universities have been converting some of their most prestigious courses to free online MOOCs and university consortia now offer each institution’s MOOCs to their collective students.<sup>16</sup>

Medical MOOCs may be designed to fulfil continuing medical education or continuing professional development needs. They may also be integrated into campus-based undergraduate programmes. Other MOOCs have a public health literacy objective or are aimed at patient education.<sup>17</sup> MOOCs are generally made available on commercial platforms without any enrolment fee for learners. Despite the massive numbers of enrolled students on some MOOCs, they are designed

to incorporate several tools to promote inter-learner interaction, including live chats, small group classrooms, discussion boards and project-based learning. The high dropout rate on most MOOCs, with average MOOC completion rates of 4-7%<sup>18</sup>, has led to assertions that completion rates should not be used as a measure of the success of individual MOOCs<sup>16</sup>, whose learners are drawn from diverse backgrounds and who approach their MOOC with individual learning goals.

Travel medicine requires a sound knowledge of tropical infectious disease epidemiology, clinical presentation and prevention. To date, very few MOOCs of relevance to travel medicine practitioners have been developed. These include MOOCs relating to disease outbreaks<sup>19</sup>, Ebola virus disease<sup>18</sup>, Zika infection<sup>19</sup>, dengue<sup>19</sup>, Chikungunya<sup>19</sup> and malaria.<sup>20</sup> The Ebola MOOC attracted 7,000 learners from 170 countries and recorded a 10% completion rate.<sup>18</sup> We aimed to design, develop, deliver and evaluate the world's first holistic MOOC in travel medicine as a transnational educational partnership initiative between two leading third-level institutions, based in Malaysia and the Republic of Ireland. The MOOC was targeted at undergraduate healthcare, primarily medical, students in order to address a recognised gap in education provision in universities worldwide.

## Methods

### *Course development*

The concept for the MOOC arose from a break-out session at the 2017 Academic Council of the International Medical University (IMU) in Kuala Lumpur, Malaysia. The subject area for the MOOC was based on a longstanding partnership in travel medicine research between the IMU and its partner medical

school in the Republic of Ireland, National University of Ireland Galway. A MOOC Lead (GTF) with 15 years of clinical experience as a travel medicine physician and multiple educational qualifications to doctoral level in travel medicine was appointed at the Academic Council meeting. An interdisciplinary project development team of academics, representing primary care, infectious diseases and public health, and e-learning technologists from IMU was established. The IMU e-Learning Lead (HZB) applied to host the MOOC on the OpenLearning® platform.

Subsequent in-person development meetings were supplemented by multiple emails and conference calls involving a core MOOC faculty of four individuals. The instructional design of the MOOC was based on the team's previous experience as MOOC developers and users and their expert knowledge of travel medicine and e-learning. Published recommendations for high quality MOOC design in the medical education literature were consulted. A syllabus outline was drafted and revised by the project team based on agreed learning objectives, comprising 5 sequential blocks or units of learning, each with 4 related themes, yielding a total of 20 themes.

Lecture recording took place at the sound-proof recording facilities at the IMU and at the NUI Galway Centre for Excellence in Learning and Teaching. A green screen approach was used which enabled the addition of relevant backgrounds for individual lectures without any extraneous distractors. Mayer's principles of multimedia teaching were followed by lecturers in an attempt to capture learners' attention and promote more active engagement with the course material.<sup>21</sup> Cross-referencing of material in the MOOC with information typically learned during microbiology, public health and clinical medicine modules in core undergraduate medical

curricula aimed to motivate the principal target learner audience of medical students. Most of the lectures were prepared and delivered by the travel medicine expert (GTF) but additional lectures were contributed by IMU-based academics. Open access journal articles written by GTF provided background reading material for users.

Formative self-assessment multiple choice quizzes (10 questions per unit) accompanied each unit and provided feedback to learners on their progress. A discussion forum was set up to encourage interaction between MOOC users and faculty. A certificate of achievement was designed which could be downloaded by users for a nominal administrative fee upon successful completion of a 25-item MCQ assessment based on the entire course material. The course was promoted by both universities to its current medical students via social media. In addition, OpenLearning<sup>®</sup> promoted the course to its extensive network of global learners. The pilot phase of the MOOC was officially launched at the 2019 Academic Council meeting as a live, facilitated course with an anticipated 5 hours of study per week for 5 weeks and was accessed on the OpenLearning<sup>®</sup> website with a secure log-in facility. Learners were enabled to learn in a self-paced manner and track their own progress as they proceeded.

### **Course evaluation**

Qualitative, free text feedback responses were obtained from medical students at the IMU and NUI Galway who volunteered to register for the MOOC during its pilot phase. No changes to course structure or content were required following feedback received after the first run of the MOOC. Recruitment of MOOC users is ongoing, having been disrupted by the COVID-19

pandemic. A 20-item course evaluation survey using a 4-point Likert scale was designed to be completed by registrants who had completed the entire course and wished to take the multiple-choice question assessment in order to receive a certificate of achievement. Demographic information and web log data, including video viewing histories, clickstreams, and participation in course discussion forums, were extracted from learning records on the MOOC platform.

### **Study ethics**

All study data were de-identified by allocating participants with a unique ID number to maintain anonymity and data confidentiality. The protocol for this study was approved by the IMU Joint Committee on Research and Ethics (IMU R239/2019).

### **Results**

#### **Course development**

Undergraduate healthcare students, especially medical students, were the primary target audience for the MOOC. The learning outcomes for the course are shown in Table 1. Course planning took approximately 6 months and was facilitated by regular asynchronous email contact and synchronous video conference and Whatsapp<sup>®</sup> group communications between the core members of the project development team based in the collaborating partner institutions. Lecture recording in soundproof recording studios against a green screen took place in January and July 2018. A further six months were required to design and populate the OpenLearning<sup>®</sup> MOOC platform, to pilot the delivery of the course and to identify and address technical issues.

**Table 1.** MOOC learning outcomes

By the end of the MOOC in travel medicine, learners should be able to:
1. Describe the role of a travel medicine practitioner
2. Comment on current global travel trends
3. Relate the key elements of travel risk assessment
4. Summarise the major travel-related infectious diseases
5. Outline an approach to travel vaccination
6. Provide basic pre-travel health advice
7. Understand the needs of special groups of travellers
8. Discuss issues relating to illness in returned travellers

Keywords were generated by lecturers and used to provide closed captions for the video lectures. The total duration of recorded lecture and demonstration video material was 4.68 hours. Lectures were generally of 5-10 minutes length each. The median lecture duration was 7 minutes 23 seconds. The longest lecture of 60 minutes in duration addressed commercial space tourism and was made available in the MOOC as a supplementary lecture in Unit 4 (specialised travellers). It had been previously recorded as a guest lecture for academic staff and students at IMU prior to development of the MOOC. While full length lectures are not recommended in online courses, this presentation was included because of its significance for both partner universities involved in developing this MOOC. Learners were encouraged to view it as a series of shorter lectures over multiple sessions. Thirty lectures given by four IMU-based academics and one academic from NUI Galway were recorded and video-scripted

using YouTube<sup>®</sup> software. These were supplemented by two demonstration videos – one recorded at NUI Galway which demonstrated the use of a portable hyperbaric chamber, and the other recorded at Tropical Medical Bureau clinic in Galway, Ireland which demonstrated how to prepare and administer a travel vaccine to a patient. Additionally, a welcome video and navigational course outline page were provided as a means of orienting learners to the MOOC.

The course was structured into five units, each with four sub-themes, representing the continuum of pre-travel, during travel, and post-travel (Table 2). Video lectures accompanied each unit, but additional lectures provided deeper coverage of selected infectious disease topics, including dengue, Japanese encephalitis and COVID-19. The course was designed to be delivered in 5-week blocks, with self-paced learning, such that each unit would take approximately 5 hours to complete. Digital badges were created to represent the completion of each unit. Learners could track their progress through the MOOC using the progress bar at the top of their screen. Relevant, published journal articles written by the MOOC Lead (GTF) expanded on material introduced in the lectures and were referred to in the lecture recordings. At the time of writing, there were web-links to 28 open access articles available in the MOOC (Table 3). The majority of articles were published in *Journal of Travel Medicine* (2019 impact factor 7.089) of which the corresponding author (GTF) is a section editor for non-communicable diseases.

**Table 2.** Course structure – units and themes

UNIT	THEMES
<b>1. Travel health risk assessment</b>	1.1 Global travel trends 1.2 Pre-travel consultation 1.3 Travel vaccinations 1.4 Transportation issues
<b>2. Pre-travel health advice</b>	2.1 Travellers' diarrhoea 2.2 Insect bite avoidance 2.3 Safety and security 2.4 Environmental hazards
<b>3. Tropical infectious diseases</b>	3.1 Vector borne diseases 3.2 Diseases spread by human contact 3.3 Food and water borne infections 3.4 Environmental infections
<b>4. Specialised travellers</b>	4.1 Medical tourism 4.2 Travellers with chronic illnesses 4.3 Pregnancy and children 4.4 Immunocompromised travellers
<b>5. Illness abroad and in returnees</b>	5.1 Insurance and medical evacuation 5.2 Accessing medical care abroad 5.3 Travel health kits 5.4 Ill returned travellers

**Table 3. Course content – lecture topics and article themes**

UNIT	VIDEO LECTURE THEMES	JOURNAL ARTICLE TOPICS
<b>Introduction</b>	Welcome to travel medicine	Bibliometric analysis Airport survey Responsible travel Medical electives Recommendations for practice Space tourism Mobile health technology in travel medicine
<b>Travel health risk assessment</b>	Travel epidemiology Travel trends in Asia Pre-travel consultation Travel vaccinations Vaccine preparation Transportation issues	Traveller priorities Travel itinerary uncertainty Personalised risk assessment
<b>Pre-travel health advice</b>	Travellers' diarrhoea Insect bite avoidance Safety and security Environmental hazards Use of a portable hyperbaric chamber	Cliff tourism fatalities Hotel fire safety Drug tourism Selfies and travel Sexual assault and rape during travel Traumatic travels Air pollution Altitude training Carbon monoxide High altitude travel Lake tourism



UNIT	VIDEO LECTURE THEMES	JOURNAL ARTICLE TOPICS
<b>Tropical infectious diseases</b>	<ul style="list-style-type: none"> <li>Vector borne disease</li> <li>Dengue infection</li> <li>Japanese encephalitis Malaria</li> <li>Diseases spread by human contact</li> <li>Food and water borne infections</li> <li>Environmental infections</li> <li>Lymphatic filariasis</li> <li>COVID-19 intermediate host</li> </ul>	Emergency self-treatment of malaria
<b>Specialised travellers</b>	<ul style="list-style-type: none"> <li>Medical tourism</li> <li>Chronic illnesses</li> <li>Pregnancy and children (part 1)</li> <li>Pregnancy and children (part 2)</li> <li>Immunocompromised travellers</li> <li>Medical aspects of space travel</li> </ul>	<ul style="list-style-type: none"> <li>Stem cell tourism</li> <li>Altitude travel with pre-existing conditions</li> <li>Eye disease and travel</li> <li>Obesity and travel</li> <li>Profile of travellers with pre-existing conditions</li> </ul>
<b>Illness abroad and in returnees</b>	<ul style="list-style-type: none"> <li>Insurance and medical evacuation</li> <li>Medical care abroad</li> <li>Travel health kits</li> <li>Ill returned travellers</li> </ul>	<ul style="list-style-type: none"> <li>Repatriation of deceased travellers</li> <li>Obtaining a travel history</li> </ul>



Interaction between peer learners and between learners and faculty was encouraged through use of the “Meet the team”, “Introduce yourself” and “Share your ideas” functions on the MOOC platform. The MOOC was unveiled at the 2019 IMU Academic Council meeting in Malaysia and a promotional video trailer and sample unit material were presented for feedback from the Council members. Each unit was assessed by a single

best answer multiple choice assessment quiz (best of 5 options) based on material covered in that unit which must be completed before the learner can receive a digital badge for that unit and progress to the following unit. Selected screenshots from the MOOC are provided in Figures 1-3. The course is available to view at

<https://www.openlearning.com/courses/travel-medicine>.

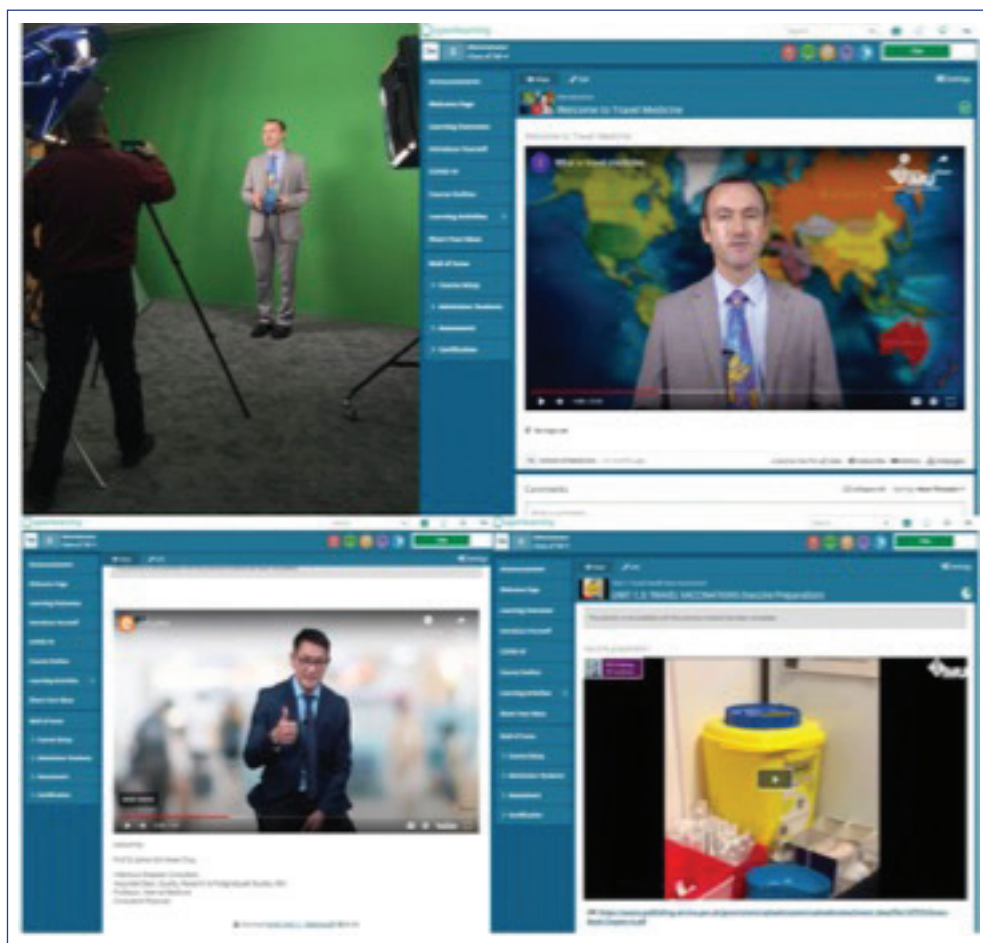


Figure 1: Screenshot from MOOC – video lecture recording



Figure 2: Screenshot from MOOC – course learning and assessment material



Figure 3: Screenshot from MOOC – selected unit content

### Course uptake

At the time of writing, 195 learners had registered for the MOOC. Demographic data are presented for the first 76 learners. The median age of the learner cohort was 21 years. The majority of learners were female (66%, n=50). All but two of the learners were undergraduate medical students; one was a pharmacy student, and one a PhD student. Learners were citizens of 14 countries, with the majority (59%, n=45) being from Malaysia. Ten of the 14 countries represented were in Asia, with 2 in Europe (Ireland and Lithuania), 1 in North America (Canada) and 1 in Africa (Kenya). Various minor technical platform issues which affected the progression between units required troubleshooting by members of the technical e-learning team at IMU. Delays imposed by the COVID-19 pandemic lockdown are likely to have influenced the uptake of the course as medical students were very preoccupied with online learning for their core modules in advance of end of academic year assessments during the period when the MOOC was first made publicly available.

Table 4 presents usage data from the first 87 learners on the MOOC. Learners viewed an average (mean) of 36.9% of all the course learning content (mean of 142.6 views per content page). They completed an average (mean) of 24.5% of the MOOC. Thirteen learners completed the end of course MCQ test and gained their certificate of achievement, yielding a MOOC completion rate of 17%. It is unknown if learners who encountered technical progression barriers abandoned the MOOC prematurely. Some learners used the “post a comment” function to highlight technical challenges and, in most cases, these were promptly resolved. The mean time spent by learners on the MOOC was 175 minutes with an average (mean) of 2.85 minutes per content page. Learners posted an average (mean) of 1.3 comments each on the MOOC platform. The mean score on the final certificate MCQ test was 75%. Figure 4 shows the daily usage profile of learners on the MOOC. Periods of peak activity occurred during the pilot phase in December 2019 and in June and July 2020. The trough of learner activity on the MOOC occurred in March, April and May 2020 and coincided with the period of global societal lockdown in response to the COVID-19 pandemic.

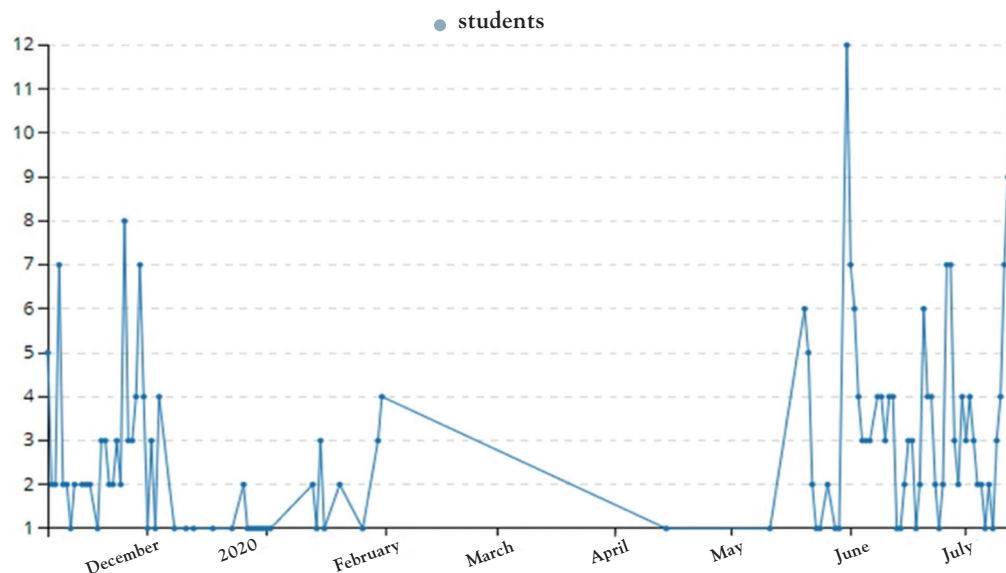


Figure 4: MOOC usage

**Table 4.** Usage data from initial cohort of MOOC learners (n=86)

MOOC CONTENT PAGE	VIEWS (n)	VIEWS (%)	COMPLETED (%)	COMMENTS POSTED (n)	MEAN TIME ON PAGE (mins)
Course outline	137	63.22	67.82	1	1
Learning outcomes	146	63.22	65.52	0	20
Welcome video	117	59.77	64.37	0	1
Introduce yourself	134	52.87	0	11	1
Introductory articles	633	42.86	34.16	6	9
Unit 1.1 lectures	105	51.72	31.03	0	2
Unit 1.2 lectures	134	47.13	29.89	6	1
Unit 1.3 lectures	193	48.28	29.89	3	2
Unit 1.4 lectures	164	47.13	28.74	1	1
Vaccination video	300	29.89	29.89	17	1
Unit 1 articles	250	47.13	16.48	1	4
Unit 2.1 lectures	112	40.23	22.99	0	1
Unit 2.2 lectures	113	39.08	22.99	6	1
Unit 2.3 lectures	77	36.78	21.84	1	2
Unit 2.4 lectures	90	37.93	21.84	1	2
Hyperbaric chamber video	84	36.78	35.63	1	2
Unit 2 articles	611	34.69	13.98	2	16
Unit 3.1 lectures	130	32.18	18.39	3	2
Unit 3.2 lectures	90	29.89	18.39	4	4
Unit 3.3 lectures	70	31.03	18.39	2	1
Unit 3.4 lectures	72	31.03	18.39	5	2
Unit 3 articles	16	5.75	5.75	0	1
Unit 4.1 lectures	62	29.89	18.39	0	1
Unit 4.2 lectures	71	29.89	18.39	2	1
Unit 4.3 lectures	123	29.89	18.39	4	2
Unit 4.4 lectures	70	29.89	18.39	3	1
Unit 4 articles	198	28.97	17.70	1	5
Unit 5.1 lectures	76	28.74	17.24	3	1
Unit 5.2 lectures	71	28.74	17.24	4	1
Unit 5.3 lectures	70	28.74	17.24	0	1
Unit 5.4 lectures	74	28.74	17.24	6	1
Unit 5 articles	80	28.17	14.37	4	2
Evaluation survey	34	17.24	17.24	1	1

### Course evaluation

For the pilot phase of the MOOC rollout, 20 medical student volunteers were invited to register for the MOOC and provide anonymous free text feedback comments. Comments were received from 50% of students (n=10), 4 students from IMU and 6 students from NUI Galway. Qualitative data were coded and subjected to thematic analysis by members of the MOOC development team. Eight themes emerged from the analysis (Table 5).

These related to the perceived educational level of the course material; learners’ attitudes towards the use of video lectures; integration of journal articles; positive effect of self-assessment quizzes on student learning; the motivational effect of the MOOC design; lack of learner interaction with faculty-suggested improvements in course delivery; and user frustration with technical issues involving progression from one unit to the next. Representative, anonymised quotations in Table 5 serve to amplify these individual themes.

**Table 5.** Themes arising from respondents’ feedback on MOOC (n=10)

THEME	REPRESENTATIVE QUOTATIONS
<p><b>SUBJECT MATTER WAS RELEVANT AND PITCHED AT THE APPROPRIATE LEVEL</b></p>	<p>“Clear objectives and learning outcomes are established.”</p> <p>“The topics were quite interesting and teaches [sic.] a lot of basic prevention of diseases spread which we don't really focus on in our medical studies.”</p> <p>“The course sheds just enough light on the topic to give us a broad overview of travel medicine and does not delve too deep into too much detail for our level.”</p> <p>“Video animations are very attractive and draws our attention to key points that the speaker is conveying.”</p> <p>“Particularly liked the way tutor put some questions to think about at the end of the lecture: personally, the more of this the better for me as it forces me to engage and reflect on my learning. This reflection elevates the MOOC to an engaging learning experience, rather than a passive one.”</p>



**LEARNERS WERE POSITIVE  
TOWARDS  
THE USE OF VIDEO LECTURES**

“I also appreciated the videos as they can be slowed down when taking notes and sped up when going over them a second time. I put on the subtitles to be able to hear and read what was being taught.”

“I was more keen to finish the videos of the topics because they are less than 10 minutes in duration. More interested and more focused with short time videos, I can go through more topics without being distracted or bored.”

“The highlighted words displayed on videos (e.g. disease names, key words) was very efficient for the learning process of the person taking the course.”

“I appreciated the way articles/ textbook excerpts were planted in the video: the combination of aural and visual aids together is very helpful.”

“The videos are of high quality and resolution.”

“The manner in which keywords and terms come up highlighted in video lectures is a very good visual aid.”

**PEER-REVIEWED  
JOURNAL ARTICLES WERE WELCOMED  
BUT COULD BE  
INTEGRATED BETTER**

“Very helpful to have real published articles to guide the Learning Unit content.”

“I would suggest to provide [sic.] a concise summary and a link to the article, if any students are interested for [sic.] some deep reading, they may click on the link and access the paper.”

“Some questions asked about the subjects covered in these papers would be helpful in focusing the student.”

<p><b>SELF-ASSESSMENT QUIZZES DROVE ACTIVE LEARNING</b></p>	<p>“Short quizzes at the end of every theme are great for testing knowledge as I find it easier to remember something after being questioned.”</p> <p>“The quiz questions were fair as they addressed during the videos, and if people were interested to read up more on specific topics to broaden their knowledge on the subject matter, research papers were generously provided for their perusal.”</p> <p>“MCQs prevent this non-taxing learning experience from becoming overly passive or non-engaging.”</p> <p>“MCQs could maybe reference which specific unit each question was taken from so that if the quiz reveals a lack of understanding of a particular topic, it would be easy to revise the relevant paper/video lecture afterwards.”</p> <p>“The MCQs are fair and not particularly challenging, you can get all the information you need from the video tutorials.”</p>
<p><b>LEARNERS WERE MOTIVATED BY THE MOOC DESIGN</b></p>	<p>“I like the progress bar at the right top corner of the screen as it helped me to track my progress. Sometimes, it even motivated me to go further when I felt like stopping.”</p> <p>“Providing badges after finishing a chapter motivated me to continue.”</p> <p>“The certificate of completion felt very satisfying and rewarding.”</p>
<p><b>GREATER LEARNER INTERACTION WITH FACULTY WAS ENCOURAGED</b></p>	<p>“There could be more interactive sessions with the faculty and students rather than displaying prepared materials.”</p> <p>“The “Share Your Ideas” page will go a long way to allow contact between student and teacher, provided it becomes a two-way conversation.”</p>



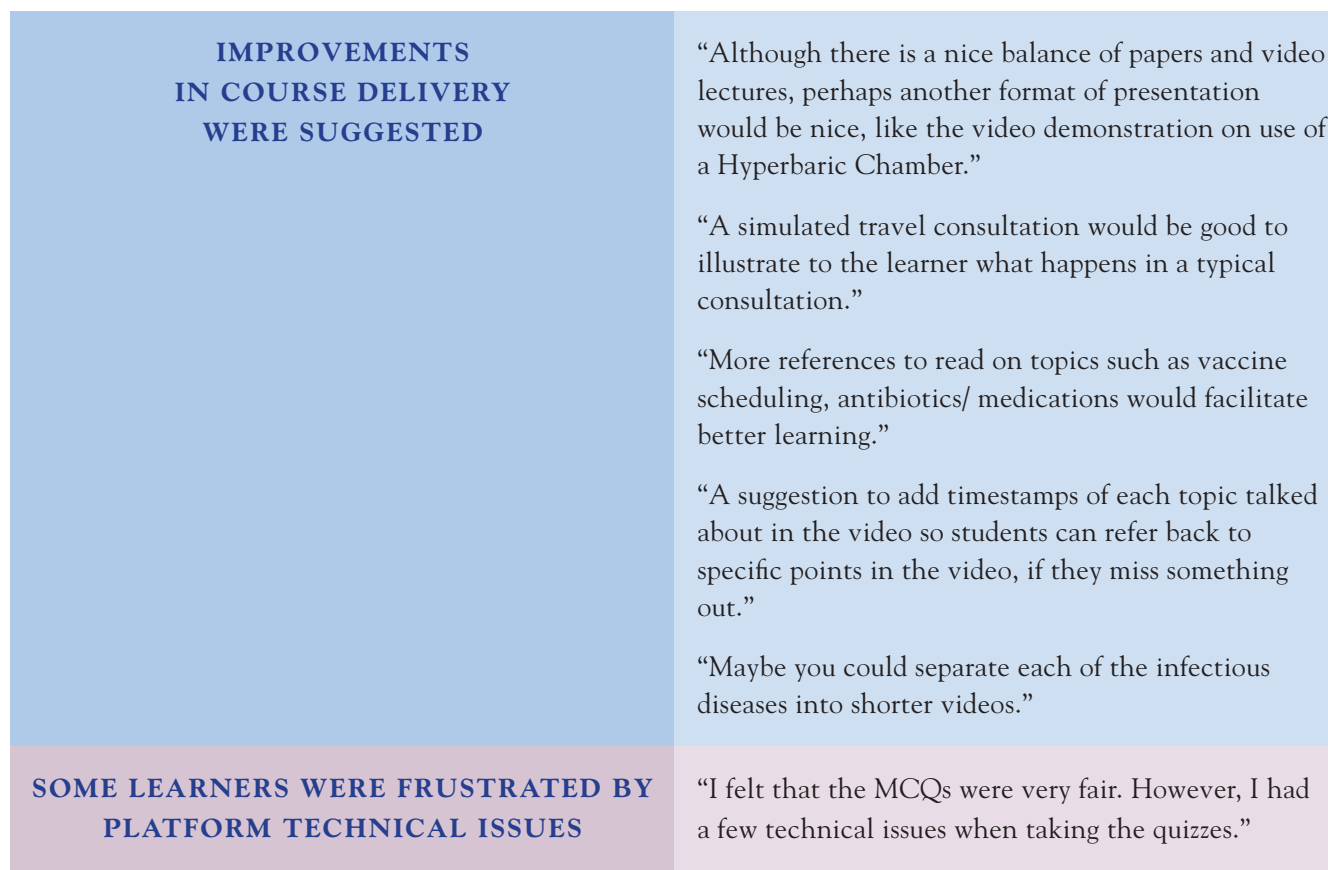


Figure 5 illustrates the high levels of satisfaction expressed in the evaluation survey by the 13 learners who completed all sections of the MOOC. Over half (54%, n=7) of the MOOC completers would strongly recommend the course to other learners and highly valued the certificate of achievement. Just under a half (46%, n=6) of MOOC completers felt strongly encouraged to register for other MOOCs, perceived a strong future career benefit from completing the MOOC, believed

the lectures to be of a very high standard, and strongly agreed that the volume of learning was manageable. Fewer MOOC completers strongly agreed with the statements “I enjoyed interacting with other learners from around the world”, “There was a good variety of learning experiences”, and “The peer-reviewed journal articles were useful”.

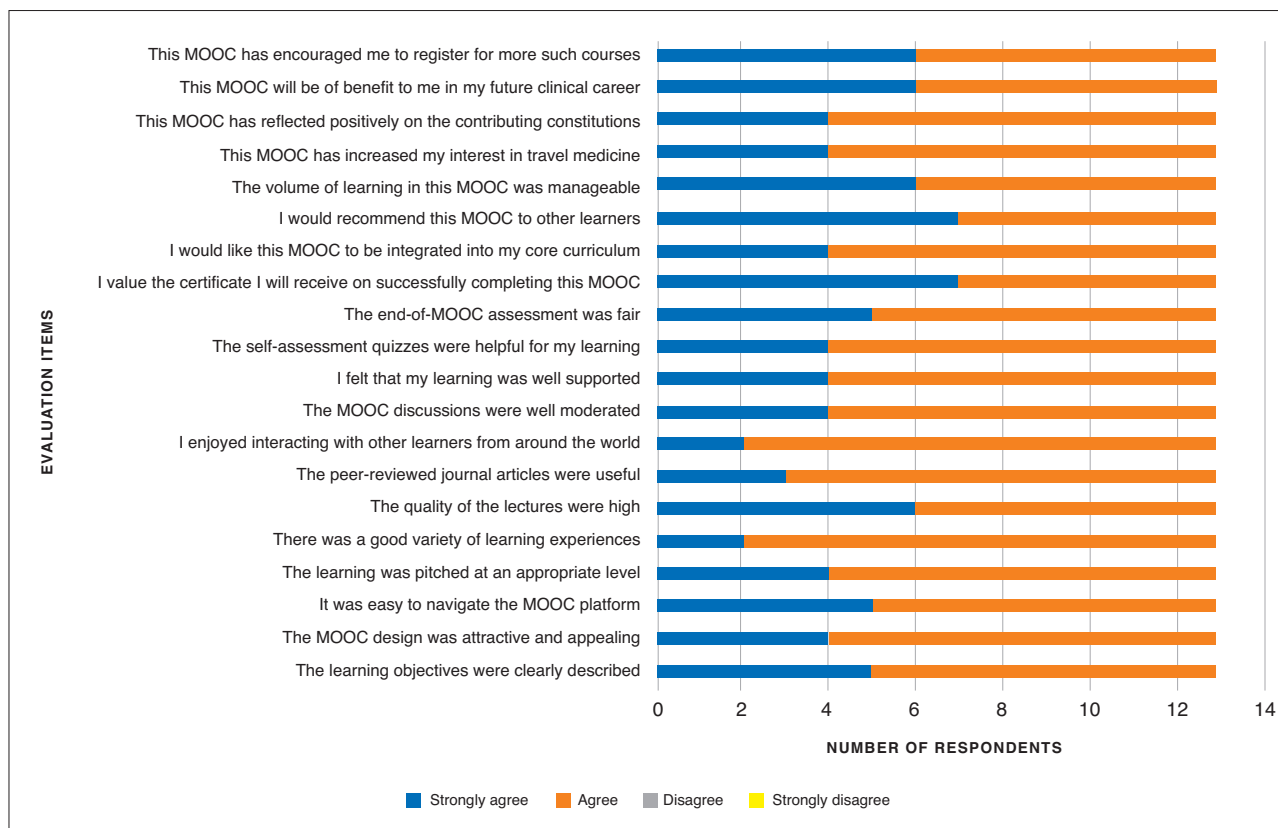


Figure 5: Questionnaire-based course evaluation

## Discussion

MOOCs represent a disruptive technology which challenges traditional educational approaches.<sup>22</sup> They provide access to information without the constraints imposed by time, cost, geography, or prior educational attainments.<sup>23</sup> By the end of 2018, there were some 11,400 extant MOOCs with 101 million learners worldwide.<sup>24</sup> The original social responsibility stimulus for MOOC development may be gradually shifting towards a corporate model where universities use MOOCs to showcase their suite of courses.<sup>25</sup> We have designed and delivered the world's first MOOC in travel medicine to a largely undergraduate cohort of healthcare professions students, the majority of whom

were medical students. The geographic origin of the MOOC registrants reflects the location of the two collaborating educational institutions, in Malaysia and Ireland. While the impetus for developing this MOOC arose from medical education breakout discussions at an Academic Council meeting, this MOOC only involved a single partner medical school, given its particular expertise and international profile in travel medicine. Future trans-national MOOCs should aim to embrace multiple collaborative institutions in order to maximise the quality of the educational product.

The challenges encountered in developing and rolling out a novel MOOC across two institutions separated by eight time zones cannot be overstated.

Regular communication between project development team members was essential in order to maintain momentum and an institutional focus on the MOOC. There was effective engagement of technical support from both universities and pre-recorded lectures were prepared using facilities at both locations. The results from the 2020 cohort of learners to date point to the high levels of learner satisfaction with the content and mode of delivery of the MOOC, particularly the use of short, captioned video lectures, demonstration videos and self-assessment quizzes based on material covered in each unit. The proposal from students to add a consultation video to the MOOC is being actively explored and our next revision of the MOOC content will also include an elaborate case study in travel medicine, which will provide further clinical context to the students' learning.

The main frustration expressed by students related to minor technical progression issues on the MOOC platform. Students used the comments function on the relevant pages to report these difficulties and they were promptly resolved. This underscores the importance of regular and attentive moderation of the MOOC by both an academic lead and e-learning technologist. Most MOOCs, including our own, have fixed course structures, with a pre-determined sequence of video lectures and supplementary learning activities which assume that learners can regulate their own learning.<sup>22</sup> Many learners prefer to exercise freedom in accessing the learning material according to their own personal requirements, baseline knowledge and time constraints. The brief time spent by some students viewing videos is typical of MOOC learners, who may choose to revisit material in a distributed fashion across multiple sessions according to their learning needs, rather than

follow a fixed sequence of content. Future MOOCs may employ artificial intelligence algorithms to personalise learning paths, by using so-called 'curious companions' to monitor learners' progress and identify content that is likely to arouse the learner's curiosity.<sup>22</sup>

While we originally intended to deliver the MOOCs in fixed five-week blocks, we opted to relax this restriction as the MOOC progressed and our level of familiarity with the platform features increased. We now believe that keeping the MOOC open on a rolling basis better serves the needs of flexible learners who may wish to register for convenience at any given time point, but this does necessitate regular input from an active and responsive moderator, or ideally a group of such moderators who can focus on individual units of the MOOC. In the early stages of the MOOC rollout, this moderation was sporadic, and this may have affected the engagement of learners initially.

The high dropout rate from MOOCs continues to challenge online education providers.<sup>14</sup> Our completion rate to date of 17% exceeds the average of 4-7% which has been reported in the literature<sup>18</sup>, but we cannot confirm if technical issues caused some learners to abandon the MOOC early. A MOOC based on an Ebola epidemic reported a 10% completion rate.<sup>18</sup> The high attrition rate of MOOCs reflects the reality that registrants may have specific personal learning objectives which may be met by completing parts of the MOOC or combining information from multiple related MOOCs. The limited number of learners who completed the end-of MOOC quiz and obtained the certificate of achievement could at least partly be explained by the cost, albeit a modest fee, charged for the certificate. Most MOOCs are free to register but levy a nominal charge for obtaining

a certificate in order to cover development costs and administrative input. While we extracted useful learning behaviour metrics from the MOOC platform, we were unable to distinguish learners into previously published categories such as “browsers” and “committed learners”<sup>26</sup>, but as a larger number of learners engage with and complete our MOOC, such learner analytics may be usefully undertaken.

Ferguson and Clow recommended that institutions provide previews of course material to facilitate more informed decision-making by learners in relation to selecting MOOCs.<sup>27</sup> We undertook such promotional efforts at the IMU in Malaysia. IMU is actively considering the integration of this MOOC into its campus-based undergraduate curriculum, perhaps as a student selected component. Developers of an Anatomy MOOC in the UK stressed the importance of ensuring that the learning objectives and academic level of a MOOC are appropriately aligned if it is going to be embedded into an existing course.<sup>17</sup> Translating content into multiple languages will further democratise MOOCs and allow participation of learners from across the globe, thus adding to the cultural diversity of the learner cohort, which is particularly important for a MOOC with a global emphasis such as our MOOC in travel medicine. This has been proposed recently for a series of MOOCs about infectious disease epidemics and pandemics.<sup>19</sup>

We were surprised that our MOOC learners did not place as high a value on peer collaboration as on other aspects of the MOOC learning experience. Merrill and colleagues found that the instructional principle of collaboration was least well represented in the MOOC courses examined in their study.<sup>28</sup> They postulated that

the difficulties in organising synchronous collaboration among MOOC participants may constitute a barrier to collaboration. Designing educational activities which promote collaborative learning should be a key objective of MOOCs. Our MOOC, with its international focus, is well positioned to achieve this. In creating this first MOOC in travel medicine, we attempted to respect the ten rules<sup>29</sup> and twelve tips<sup>30</sup> for MOOC design. Rule ten refers to the importance of debriefing and this is proposed for an in-person session at the next Academic Council meeting. Analysis of the learning patterns evident from a larger cohort of participants should provide further insights which will assist in future revisions of the MOOC.

The COVID-19 global pandemic has accelerated progress towards the migration of traditional pedagogical output to an online environment. The 2021 conference of the International Society of Travel Medicine, which was due to take place for the first time in Asia as an in-person event in Kuala Lumpur, will now take the form of a fully virtual meeting. The potential for MOOCs such as ours to have an adjunctive role in the continuing professional development of travel medicine practitioners is significant. Furthermore, our MOOC could, with some modifications, serve as a useful tool for increasing the awareness of the travelling public and travel industry towards the importance of travel health issues.

### **Study limitations**

Our capacity to promote this MOOC in travel medicine and recruit participants in its first phase was constrained by the effects of global pandemic lockdown. We chose a set cut-off point to complete our analysis

of the course uptake and learner behaviour. Whether similar patterns of engagement and completion rates will be observed in future runs of the MOOC remain to be seen. Our MOOC was only available in the English language which may have been a further barrier to its uptake in many countries. We did not employ usability metrics to evaluate the learner experience, but we intend to apply Neilson's heuristics of user interphase design<sup>31</sup> in our next formal evaluation of a larger number of MOOC learner, in order to identify the strengths and weaknesses of this online course.

### **Future research opportunities**

Future research should explore learner motivations for MOOC participation, the factors which correlate with higher levels of MOOC engagement and completion, and the influence of MOOCs on subsequent educational achievements and career choices.

### **Conclusions**

Travel medicine remains a largely postgraduate discipline although there is growing interest in its introduction at an earlier stage in health professions curricula. This is the first introductory MOOC in travel medicine. It may provide a model for development of other collaborative international e-learning courses. It addresses a significant deficit in undergraduate health professions education and may prove a useful springboard for the development of further MOOCs on related subjects at both introductory and advanced levels.

**Acknowledgements:** We are grateful to the Academic Council of the IMU for its enthusiastic support of this collaborative educational venture. We sincerely thank Prof James Koh Kwee Choy, Dr. Verna Lee and Prof Patricia Lim Kim Chooi, who contributed video lectures for the course. We also express our sincere gratitude to Ms. Eileen Walsh, e-learning technologist at the School of Medicine, NUI Galway, and technical support staff at both the IMU and the Centre for Excellence in Learning and Teaching at NUI Galway. Thank you also to Ms. Joyce Keaveney, travel health nurse, for her demonstration of travel vaccination technique. Consent was kindly provided from the patient featured in the video.

**Authors' contributions:** GTF was responsible for conception and design of the study. GTF, BCWL, ALA, HZB and LL contributed to the development of the MOOC. All authors were responsible for interpretation of data arising from the MOOC. The first draft manuscript was prepared by GTF with input from BCWL. The draft was edited for significant intellectual content by all other authors. Each author read and approved the final version of the manuscript.

**Conflict of interest:** None declared

**Funding:** None received

#### REFERENCES

- Hellberg H. Matkailulääketiede-uusi lääketieteen haara [Travel medicine-a new discipline]. *Duodecim*. 1977;93(23):1485-1486.
- Piyaphanee W, Chanthavanich P. Residency training in travel medicine-a 3-year journey to become a specialist. *J Travel Med*. 2016;23(5):10.1093/jtm/taw041.
- Coyle DJ, Flaherty GT. An educational journey in travel medicine: content analysis of CISTM conferences, 1988-2017. *J Travel Med*. 2019 May 10;26(3). pii: tay121. doi: 10.1093/jtm/tay121.
- International Society of Travel Medicine. 2020. Online learning program. Available at: <https://www.istm.org/onlinelearningprogram> (last accessed 7 August 2020).
- G Flaherty, D Browne. Citation analysis of travel medicine literature: a descriptive review of the most influential publications. *International Journal of Travel Medicine and Global Health* 2016; 4(4):122-131.
- Flaherty GT, Lim Yap K. Bibliometric analysis and curriculum mapping of travel medicine research. *J Travel Med*. 2017 Sep 1;24(5). doi: 10.1093/jtm/tax024.
- Oh KE, Flaherty GT. Travel medicine research in the new millennium: A bibliometric analysis of articles published in *Travel Medicine and Infectious Disease*, 2003-2019. *Travel Med Infect Dis*. 2020 Jan - Feb;33:101549. doi: 10.1016/j.tmaid.2019.101549.
- Kozarsky P. The Body of Knowledge for the practice of travel medicine - 2006. *J Travel Med*. 2006;13(5):251-254.
- Flaherty G, Thong Zi Yi C, Browne R. The missing link: introducing travel medicine into the undergraduate medical curriculum. *J Travel Med*. 2016 Jul 4;23(5). doi: 10.1093/jtm/taw038.
- World Tourism Organization. *Tourism Towards 2030/Global Overview*. Madrid; 2011.
- Glaesser D, Kester J, Paulose H, Alizadeh A, Valentin B. Global travel patterns: an overview. *J Travel Med*. 2017;24(4):10.1093/jtm/tax007.
- Zhao F, Fu Y, Zhang QJ, Zhou Y, Ge PF, Huang HX, He Y. The comparison of teaching efficiency between massive open online courses and traditional courses in medicine education: a systematic review and meta-analysis. *Ann Transl Med*. 2018 Dec;6(23):458. doi: 10.21037/atm.2018.11.32.
- McAulay A, Tewart B, Siemens G. *The MOOC model for digital practice*. 2010. Charlottetown: University of Prince Edward Island. Available at: [http://www.elearnspace.org/Articles/MOOC\\_Final.pdf](http://www.elearnspace.org/Articles/MOOC_Final.pdf) (last accessed 7 August 2020).
- Tseng SF, Tsao YW, Yu LC, Chan CL, Lai KR. Who will pass? Analyzing learner behaviors in MOOCs. *Res Pract Technol Enhanc Learn*. 2016;11(1):8. doi: 10.1186/s41039-016-0033-5.
- Downes S. Places to Go: Connectivism & connective knowledge. *Innovate: Journal of Online Education* 2008;5(1):1-6.
- Hendriks RA, de Jong PGM, Admiraal WF, Reinders MEJ. Instructional design quality in medical Massive Open Online Courses for integration into campus education. *Med Teach*. 2020 Feb;42(2):156-163. doi: 10.1080/0142159X.2019.1665634.
- Swinnerton BJ, Morris NP, Hotchkiss S, Pickering JD. The integration of an anatomy massive open online course (MOOC) into a medical anatomy curriculum. *Anat Sci Educ*. 2017 Jan;10(1):53-67. doi: 10.1002/ase.1625.
- Evans DP, Luffy SM, Parisi S, Del Rio C. The development of a massive open online course during the 2014-15 Ebola virus disease epidemic. *Ann Epidemiol*. 2017 Sep;27(9):611-615. doi: 10.1016/j.annepidem.2017.07.137.
- Bendezu-Quispe G, Torres-Roman JS, Salinas-Ochoa B, Hernández-Vásquez A. Utility of massive open online courses (MOOCs) concerning outbreaks of emerging and reemerging diseases. Version 2. *F1000Res*. 2017 Sep 18;6:1699. doi: 10.12688/f1000research.12639.2.
- Chabriere E, Parola P. Malaria: Massive open online courses MOOC. *Travel Med Infect Dis*. 2016 Nov-Dec;14(6):636. doi: 10.1016/j.tmaid.2016.10.012.
- Mayer RE. *The Cambridge Handbook of Multimedia Learning*, 2nd edn. Cambridge University Press, Cambridge, 2014.
- Yu H, Miao C, Leung C, White TJ. Towards AI-powered personalization in MOOC learning. *NPJ Sci Learn*. 2017 Dec 14;2:15. doi: 10.1038/s41539-017-0016-3.
- Goldberg LR, Crocombe LA. Advances in medical education and practice: role of massive open online courses. *Adv Med Educ Pract*. 2017 Aug 21;8:603-609. doi: 10.2147/AMEPS115321.
- Shah D. *By the Numbers: MOOCs in 2018*. Available at: <https://www.class-central.com/report/mooc-stats-2018/> (last accessed 7 August 2020).
- Wakefield A, Cartney P, Christie J, Smyth R, Cooke A, Jones T, King E, White H, Kennedy J. Do MOOCs encourage corporate social responsibility or are they simply a marketing opportunity? *Nurse Educ Pract*. 2018 Nov;33:37-41. doi: 10.1016/j.nepr.2018.08.020.
- Koller K, Ng A, Do C, Chen Z. 2013. Retention and intention in massive open online courses. In depth. Available at: <http://www.education.edu/ero/article/retention-and-intention-massive-open-online-courses-depth-0>. (last accessed 7 August 2020).
- Ferguson R, Clow D. 2015. Examining engagement: analysing learner subpopulations in massive open online courses (MOOCs). In 5th International Learning Analytics and Knowledge Conference (LAK15), 16-20 March 2015. Poughkeepsie.
- Merrill MD. First principles of instruction. *Educ Technol Res Dev*. 2002;50(3):43-59.
- Manalack DT, Yuriev E. Ten Simple Rules for Developing a MOOC. *PLoS Comput Biol*. 2016 Oct 20;12(10):e1005061. doi: 10.1371/journal.pcbi.1005061.
- Pickering JD, Henningsohn L, DeRuiter MC, de Jong PGM, Reinders MEJ. Twelve tips for developing and delivering a massive open online course in medical education. *Med Teach*. 2017 Jul;39(7):691-696. doi: 10.1080/0142159X.2017.1322189.
- Nielsen J. 10 usability heuristics for user interface design. Available at: <https://www.nngroup.com/articles/ten-usability-heuristics/> (last accessed 2 September 2020).