Tampere University

HEINI UTUNEN

Health Information Dissemination During Pandemics and Epidemics

Key requirements for online learning platforms and materials

Tampere University Dissertations 808

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ACADEMIC DISSERTATION
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Dedication

Dedicated to my adorable and smart children, Pepe Elias and Miki Ilias.

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I would like to thank my dissertation supervisors – Professor, Dr J. Tuomas Harviainen; University lecturer, Dr Heidi Enwald; and Director, Dr Gaya M. Gamhewage – for your guidance and inspiration, your ideas, critical questions, and commitment to my work. I am privileged to have had you as my supervisors and have learnt immensely from you.

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I owe my sincerest thanks to the Faculty of Information Technology and Communication Sciences where I have had the privilege of being enrollled in a Doctoral Programme in Information Studies and Interactive Media since 2019. Working in research and publishing in the scientific domain is a new passion for me.

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ABSTRACT

The thesis examined dissemination of public health information through asynchronous online learning provision. The context is public health emergencies, and the study includes evidence from epidemic and pandemic learning responses through online dissemination targeted to health professionals and open to any interested audiences. The research is placed at the crossroads of information dissemination, health communication and learning technologies. The research investigated key considerations for platform requirements to mount a learning response with a global reach; and core requirements for the learning material packaging to suit massive audiences. The thesis consists of four publications of which three provide evidence on COVID-19 online learning material, and one provide evidence from other infectious disease online courses on Ebola. Statistics-driven findings were made based on meta-data analysis of the World Health Organization's (WHO) open-source learning platform, OpenWHO.org, and included platform-wide big data metrics and several survey analyses. All data and evidence outputs were analysed utilising the thematic analysis approach and were coded into emerging themes of importance that shed light on the utility of the information dissemination. The study sought to operationalise key considerations relating to health information dissemination as an asynchronous online learning delivery and recommends two frameworks; one for considerations relating to platform capabilities and the other for aspects relating to the packaging of online learning material. The findings of this thesis can inform any learning provider who operates through online learning means with an aim to reach unlimited mass audiences in an easily scalable way, with particular emphasis on adjustments required for sudden onset events and emergencies where the aim is to save lives through online learning and information dissemination.

Keywords: health information and communication, information dissemination, online learning, massive open online course, asynchronous learning, equity, open-source learning, COVID-19, pandemic, epidemics, infectious diseases, public health emergency, OpenWHO

TIIVISTELMÄ

Tämä väitös tutki terveystiedon levittämistä asynkronisena verkko-oppimistarjontana terveyskriiseissä erityisesti terveysalan ammattilaisille, ja samalla kenelle tahansa avoimista verkko-oppimisaineistoista kiinnostuneelle. Tutkimus sisältää aineistoja epidemia- ja pandemia-aiheisista ja -aikaisista laajamittaisesta oppimisvasteesta ja se sijoittuu informaatiotutkimuksen, terveysviestinnän ja oppimisteknologioiden aloille. Tutkimuksessa tarkasteltiin edellytyksiä maailmanlaajuiselle oppimismateriaalin levittämiselle, niin aineiston kuin verkko-oppimisympäristön näkökulmasta. Väitös pohjautuu neljään vertaisarvioituun tutkimusartikkeliin, joista kolme käsittelee COVID-19 -pandemian aikaista terveystiedon levittämistä ja käyttöä ja yksi artikkeli Ebolaa. Tilastotieteellisiin havaintoihin perustuvat datan meta-analyysit pohjautuvat Maailman Terveysjärjestön (WHO) avoimeen verkko-oppimisympäristöön, OpenWHO.org, ja sisältävät koko oppimisymparistön kattavaa suurta dataa ja kyselypohjaisia analyyseja. Julkaisujen aineistot käsiteltiin temaattisen analyysin keinoin ja niistä nousevat teemat koottiin verkko-oppimisympäristöja ja -aineistoja koskeviksi suosituksiksi. Tutkimus pyrki hahmottamaan ja toiminnallistamaan keskeisiä elementtejä ja huomioitavia näkökulmia terveysinformaation välittämisestä omatahtisena verkko-oppimisena. Tutkimuksessa esitetään kahta eri viitekehystä reaaliaikaisen, verkko-oppimisen kautta tehtävän terveystiedon levittämisen tueksi: oppimisympäristöjen kapasiteettiin liittyviä ja verkkojen kautta jaeltavien aineistojen muotoihin liittyen. Väitöskirjatutkimuksen tulokset voivat hyödyttää tiedontuottajia, jotka tarjoavat verkko-oppimisympäristöjä, tavoitteenaan saavuttaa laaja määrä oppijoita helposti skaalautuvilla keinoilla erityisesti yhtäkkisissä ja nopeasti etenevissä kriisitilanteissa, joissa ensisijainen tarkoitus on pelastaa ihmishenkiä.

Asiasanat: terveystieto ja -viestintä, tiedonjakelu, verkko-oppiminen, massiivinen avoin verkkokurssi, asynkroninen oppiminen, oikeudenmukaisuus, avoimet oppimisympäristöt, COVID-19, pandemia, epidemia, tartuntataudit, terveyskriisit, OpenWHO

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ABBREVIATIONS

CDC	Centers for Disease Control and Prevention
cMOOCs	connective Massive Open Online Courses
COP	Certificate of Participation Certificate
COVID-19	Coronavirus Disease, infectious disease caused by the SARS-CoV-2 virus
DRC	Democratic Republic of Congo
EdTech	Education Technology
ERC	Emergency Risk Communication
LDC	Least Developed Country
LMICs	Low- and middle-income countries
MOOCs	Massive Open Online Courses
OECD	Organization for Economic Co-operation and Development
OpenWHO	An online learning platform of the World Health Organization's Health Emergencies Programme
PAHO VC	Pan-American Health Organization's (PAHO) Virtual Campus (VC)
ROA	Record of Achievement Certificate
SARS	Severe Acute Respiratory Syndrome
SDG	Sustainable Development Goals
UNESCO	United Nations Education, Science and Culture Organization
WB	World Bank
WHO	World Health Organization
xMOOCs	eXtended Massive Open Online Courses

ORIGINAL PUBLICATIONS

Publication I Utunen, H. (2020). Digitizing basic occupational health and safety knowledge for Ebola virus disease missions – Reaching frontline responders through an online course. In M. Cacace R. Halonen, H. Li, T. P. Orrensalo, C. Li, G. Widén, & R. Suomi (Eds.), *WIS 2020: Well-Being in the Information Society: Fruits of Respect (*pp. 265-282). (Communications in Computer and Information Science, No. 1270) https://link.springer.com/chapter/10.1007/978-3-030-57847-3_19

Publication II Utunen, H., Ndiaye, N., Piroux, C., George, R., Attias, M. & Gamhewage, G. (2020). Global reach of an online COVID-19 course in multiple languages on OpenWHO in the first quarter of 2020: Analysis of platform use data. *Journal of Medical Internet Research, 22*(4), e19076. https://www.jmir.org/2020/4/e19076

Publication III Utunen, H., George, R., Ndiaye, N., Attias, M., Piroux, C. & Gamhewage, G. (2020). Responding to global learning needs during a pandemic: An analysis of the trends in platform use and incidence of COVID-19. *Journal of Education Science*, *10*(11), 345. https://www.mdpi.com/2227-7102/10/11/345

Publication IV Utunen, H., Tokar, A., Arabi, E. & Gamhewage G. (2022). Online learning for mass audiences during the COVID-19 pandemic: Key considerations for real time knowledge transfer. *International Journal of Emerging Technologies in Learning, 17*(4), 112-134. https://doi.org/10.3991/ijet.v17i04.27569

Publications I-IV reprinted by the permission of the publishers.

Author role and description of the author's role in each sub-study

The author has been studying for her doctorate during her employment at the World Health Organization (WHO). The position at the WHO is Technical Officer in the Learning and Capacity Development Unit of the WHO Health Emergencies Programme. In the function, the author has been managing the OpenWHO.org platform. The author conceived and led the implementation of all studies contained within this thesis; however, the original publications include contributions from others in the team who implemented the work, and their contributions are explicitly acknowledged in the thesis. The author alone is responsible for the views expressed in this thesis. These views do not represent the decisions or policies of the WHO.

Study I: I conceived the study topic fully myself and authored the entire research paper independently.
Study II: I conceived the study scope, established the data gathering framework, conducted the analysis of data and wrote the body of the paper. Co-authors supported with language editing, extracted and polished the data entries, verified the contents and provided critical comments and searched for relevant literature background.
Study III: I conceived the study, established the data points gathering framework to combine platform data with the incidence of COVID-19 data, supervised the analysis of data and wrote the template body of the paper. Co-authors supported with language editing, extracted and polished the data entries, overlaid the OpenWHO data and COVID-19 case count data, verified the contents and provided critical comments and searched for relevant literature background. The co-authors helped in finalising the last legs of the writing of the article into the final format.
Study IV: I conceived the study scope, fully completed the OpenWHO specific data analysis and writing work including data, findings, discussion, and conclusions. Co-authors led the literature review and data extraction which I supervised, and I contributed to the search scope of articles and categorization. Co-authors supported with language editing, verified the contents and provided critical comments.

1 INTRODUCTION

The novel pathogens and existing infectious diseases with epidemic and pandemic potential continue to present a significant challenge to the world. The COVID-19 pandemic and other health emergencies highlight the need for all health personnel to access timely health information to respond safely and effectively to these events. Understanding diseases and finding solutions for health-related emergencies among health professionals and at the community level, in ways appropriate for the relevant cultures, will help contain any outbreak and health emergency and reduce human suffering and loss. When the helpers have evidence-based information, they are better equipped to provide support in the affected communities and save lives. When affected populations can make informed decisions relating to their health and survival, the diseases can be contained faster, further infections can be prevented and recovery from any health emergencies is quicker (WHO, 2021).

Health information dissemination and health literacy are aspects of health promotion with the goal of getting people to reach their fullest health potential. Health promotion according to the Ottawa Declaration (WHO, 1986), is "*the process of enabling people to increase control over, and to improve, their health*." Nutbeam (2000) defines health literacy as "*the ability to engage with health information and services, disease prevention, and health promotion*." Health literacy enables individuals and health services to stay informed during a health emergency to protect their health. In line with this goal of health promotion, WHO aims to achieve equity through its online and other learning programmes covering health emergency information dissemination.

The introduction of the internet and online access have fundamentally changed the way in which the majority of the world's population live, consume, acquire information, communicate, and learn (Haigh et al., 2015). Digitalisation has brought learning increasingly to online formats and the impact of this during the pandemic was very evident. In a world where internet connection is within reach for increasing

numbers of global populations, there is a promise to advance critical information from the authorities to wider audiences through online means.

This study sits at the junction between information studies, learning technologies and health communication. It focuses on information dissemination from the information provider point of view and the context is online information dissemination of organization's information to mass audiences during health emergencies. The study shows the importance of offering real-time, asynchronous, self-paced learning material online as the first information and knowledge component on disease outbreaks, and related health emergency management topics.

1.1 Research background

The World Health Organization (WHO) works to prevent and lessen the impact of epidemics and pandemics by e.g., consolidating scientific evidence from a wide range of disciplines and sectors, and translating them into comprehensive and scalable interventions for priority diseases. Timely response to information needs, in rising emergency situations, is vital, and with information and education from a trusted health authority, the diseases can be contained faster, further infections can be prevented and recovery from the crisis will be quicker. Through information dissemination the capabilities relating to health literacy, especially of health workers, can be improved. Furthermore, health information has an important function in anticipating, understanding and managing infodemics (WHO, 2021). Since the onset of the COVID-19 pandemic, an infodemic has emerged, described by WHO as "*an overabundance of information – some accurate and some not*" (WHO, 2020, p. 1). Tailored information, including fast response to misinformation, is a core activity for WHO teams in managing the infodemic (WHO, 2020, Zarocostas, 2020).

When reports of the novel coronavirus (SARS-CoV-2) first emerged in January 2020, the OpenWHO.org team expedited learning material production with WHO science experts (Utunen, Ndiaye, Zhao et al., 2020b). The content production was accelerated as the first WHO Emergency Committee meeting took place 22-23 January 2020. First novel coronavirus course was launched in open-source format

on 26 January 2020, three days before the declaration of COVID-19 as a Public Health Emergency of International Concern (PHEIC) on 30 January 2020. WHO science experts supported the OpenWHO team to adapt existing WHO evidence on SARS-CoV-2 virus into online learning courses (Utunen, Van Kerkhove, et al., 2021a). Since January 2020, the OpenWHO team has continued to provide open-access health information on the COVID-19 pandemic based on available scientific information on various aspects of the pandemic response (Utunen, George, Ndiaye et al., 2021).

The pandemic was a question of when, not if, for the WHO. The platform provided learning for various epidemic events such as Ebola, Pneumonic plague and Diphtheria, but the planning for the platform solutions were readied for a pandemic (Utunen, Attias, George et al., 2020c). The OpenWHO platform was launched in 2017 to facilitate learning and information dissemination for emergencies on a massive scale, in anticipation of the next pandemic (Utunen et al., 2018). Based on the 2014-2015 challenging response to the Ebola outbreak of West Africa, it became clear that a crucial tool in the fight against epidemics and pandemics would be getting timely, accurate, up-to-date information to the responders. This was the foundational context for OpenWHO (Gamhewage, Utunen, & George, 2020).

OpenWHO allows unlimited audiences to access open-source, self-paced, asynchronous online courses that present WHO's operational guidance. This is done with the firm belief that people have a right to information to protect themselves and their communities. The challenge for all international actors is to get the latest science into the hands and minds of decision-makers and front-line responders rapidly. As a foundational value, the platform aims for as equitable access to learning as possible and does so by removing all barriers which may remit its functions (George, Utunen, Ndiaye et al, 2022). Platform provides free, multi-lingual, low-bandwidth accessible and downloadable formats (George, Utunen, Willems et al., 2021).

The OpenWHO platform provides courses in Massive Open Online Courses (MOOCs) formats. MOOCs arose in the education sector as advancements in digital technology allowed this educational modality. The fast advancement of information and communication technologies has impacted the higher education sector and contributed to the creation of these new technological means, such as MOOCs. The promise of the MOOC was immense in the way it would democratise learning,

achieve completely new levels of results in education and, eventually, lead to true life-long learning (Porter, 2015).

1.2 Research context

The MOOC format suits global dissemination and demand to understand global and local health threats and other health hazards in the 21st century. The major epidemics of past decades, from SARS to the Zika virus, from yellow fever to the influenza pandemic, have emphasised the need for a technology that can support dissemination of scientific information to the frontline. Infectious disease outbreaks, when looking at outbreaks before COVID-19, occur predominantly in the southern hemisphere countries. According to the WHO annual report of 2018 on *Work in emergencies: prepare, prevent, detect and respond*, a total of 481 health events were reported in 141 countries and territories. Some of these public health events are caused by well-known diseases but also include novel pathogens. These are usually poorly understood by the scientific community, with great potential to cause widespread outbreaks, and often associated with high case-fatality rates, with no efficient preventive treatments or vaccines (WHO, 2019).

In 2019, of a total of 483 public health events detected by WHO, 22% were registered in the WHO African region, which accounted for the highest burden of disease outbreaks, with the most frequently reported being: cholera (20.8%), measles (11.5%), and yellow fever (7.3%) (WHO, 2020). There were eleven countries that reported at least four health events of infectious disease outbreaks in 2018 (Mboussou et al., 2018). The need for outbreak, epidemic and pandemic real-time learning response is evident. Receiving the science-informed information, at the right time, serviced in most appropriate formats can save lives, reduce human suffering, improve survival and recovery and protect the livelihoods during humanitarian health crises and disease outbreaks. Lack of adequate, culturally appropriate information on health threats can turn against the purpose and at worst lead to escalation of the events at the disease epicentres (Gamhewage, Utunen, & Attias, 2020, Utunen, Attias, George et al., 2022).

Conducting this research derives from a real-life need to understand and decipher how self-paced learning at its best can work in contexts where large numbers of

health responders and general audiences need to access new health information within short intervals from an emerging pathogen or other emerging health threat. The study aims to capture the use of MOOC materials in epidemic and pandemic contexts, and in particular for contexts that are remote with no or compromised internet connectivity. To fill the accessibility gap has meant harnessing new technology, and scaling up course production, formats, dissemination channels and languages to meet the evolving needs of the learners.

The OpenWHO platform focuses on the extended Massive Open Online Course (xMOOC) modality, which is one-to-many modelled, and self-paced for scalable learning. In this thesis a description is made on how OpenWHO utilized xMOOCs to reach mass audiences during the COVID-19 pandemic. The OpenWHO use case and evidence highlight that the core health information dissemination needs to be planned as the constant change related to health information and advice is a driver for audiences to join and re-join learning to refresh their knowledge, especially in the case of novel infectious diseases. The pandemic response required millions of people, especially health emergency responders, to access health information.

1.3 Aim of the thesis

The thesis examined health information dissemination through asynchronous online learning provision. The context is public health emergencies, and the study includes evidence from epidemic and pandemic learning responses through online dissemination to mass audiences. The primary goal was to determine which key enabling factors provide equitable learning experiences for mass audiences. The research investigated key considerations for platform requirements to mount a globally reaching learning response and core requirements for the learning material packaging to mass audiences.

The research is interdisciplinary, and the sources are from the domains of information studies, learning technologies and health communication. In addition to filling the research gap on just-in-time learning response through mass modes in

asynchronous formats, it provides key considerations for any information provider of a mass scale intervention. This study builds on the existing body of evidence on online learning in global, equitable and disseminated contexts and it contributes to the advancement of well-organized, predictable and managed information dissemination through learning in public health emergencies.

This study explores health emergency information dissemination in the context of the emergencies and in online modalities in massive scale during the pandemics and epidemics. It fills the literature gap relating to asynchronous, one-directional online learning at mass scale and related online learning platform requirements and design of the massively scalable material dissemination. Continuous learning with timely, consistent, clear and comprehensive information might serve as a facilitator to healthcare workers' adherence with scientific guidance and help prevent health care associated infections. In this regard, online learning, which provides up-to-date, accessible, and comprehensive information, can have a significant role. Online learning approaches give learners flexibility with learning materials as they are instant, always available and meet the current needs of learners to be adaptive and faster to identify and address health-related information and knowledge gaps.

The research scope is limited to the information dissemination modalities in online formats from the learning provider perspective. The research covers the aspects of the learner through learner completion and attendance but does not cover the aspects of the learner behaviour change, comprehension and learning outcomes and application. The research is not about targets of the health care systems such as patients, but rather the audiences who have voluntarily decided to enrol for self-paced online learning.

The COVID-19 pandemic has highlighted numerous barriers including in training for health workers to apply in their practices and behaviours and there were many health worker infections, particularly early in the pandemic.

The research provides inputs to the information studies from the point of view of information dissemination in mass modalities and to the learning technologies in MOOCs, where asynchronous learning has a critical place in health emergencies information dissemination. The study adds evidence relating to fully free learning and information dissemination that is not readily available on a global scale, and show the value of xMOOCs, extended Massive Open Online Courses, especially in the sudden onset emergencies that touch the whole world, such as the COVID-19 pandemic.

1.3.1 Research objectives

The role and means of real-time asynchronous information dissemination during an emergency have not been widely reported. The aim of this thesis was to gain an understanding of health information dissemination during emergencies done through online learning during a pandemic and a few selected epidemic responses. Based on findings, this thesis is presenting key considerations for practitioners in online learning domains, to consider and establish adequate means for massive scale information dissemination as an asynchronous and accessible learning provision. This research looks into information dissemination for mass audiences and aims to establish if existing models are adequate for health emergency information dissemination from a learning provider's point of view, or if there are gaps in approaches and a need for new models to be established.

The following research objectives were set for the study:

1. Examine elements of a successful massive scale health information dissemination through asynchronous formats.
2. Investigate the use of massive open online courses during epidemics and pandemics.
3. Draw findings from health information dissemination and learning provision through online platforms at a massive global scale.
4. Depict the minimum requirements for the packaging of materials suited to online learning to upscale the use and dissemination.
5. List platform requirements and elements informing digitalised learning material packaging requirements to disseminate information successfully.

1.3.2 Research questions

The key requirements for online learning platforms and learning material dissemination for mass audiences were investigated through service use data. The

results contribute to findings on how just-in-time learning response in a health emergency can be made fit for mass audiences through information dissemination in which an online platform and self-paced learning material packaging are used. This thesis is concluding research based on four separate studies (the publications I-IV), which all have aspects relating to the information dissemination from the expert organisation through online means in infectious disease outbreaks, epidemics, and pandemics. The studies together contribute to a wider understanding of the topic in health emergencies. With the evidence arising from the studies, this thesis responds to the following synthetising research questions that are targeted for all four studies:

Research question 1: What are the key requirements for information dissemination using an asynchronous online learning platform to mount a globally reaching learning response in a health event?

Research question 2: How can packaging for self-paced online learning materials ensure massive scale up to allow global information dissemination?

There are practical needs in researching health information dissemination in emergencies so that the use and effectiveness of the information materials provided through online means to the frontline and any willing learner can be planned and designed for maximum reach and access. When the critical actors in health emergency have the evidence-based information at the right time, the impact can be counted in lives protected and saved.

1.4 An overview of the articles

The thesis consists of four articles, of which three provide evidence on COVID-19 and one on Ebola information dissemination through online means.

Study I: Digitizing basic occupational health and safety knowledge for Ebola virus disease missions – reaching frontline responders through an online course

This paper investigates the WHO's ePROTECT course, an occupational health and safety online briefing for Ebola Virus Disease (Ebola) that has become a key resource for responders battling Ebola on the frontline across different professional

roles in various organisations, mainly in the Democratic Republic of Congo (DRC) and its neighbouring countries. ePROTECT is a basis of the WHO's duty of care and is mandatory for personnel before being deployed on Ebola missions by WHO. The study looked at the use case: user patterns, locations, backgrounds, and affiliations. A user survey was sent to all active course users to understand their motivation for taking the course.

Study II: Global reach of an online COVID-19 course in multiple languages on OpenWHO in the first quarter of 2020: Analysis of platform use data
At the onset of the coronavirus outbreak, the World Health Organization's (WHO) Health Emergencies Programme developed a massive open online course within just three weeks to provide the foundation for the global response to the emergency. The introductory coronavirus disease (COVID-19) course was launched on January 26, 2020 on OpenWHO.org. The study investigated the geographic reach of courses presented in different languages accessed by a worldwide audience seeking information on COVID-19. Users' professional identities and backgrounds were explored to inform course owners on the use case. The self-paced course was available in 13 languages during January 26 and March 25, 2020.

Study III: Responding to global learning needs during a pandemic: An analysis of the trends in platform use and incidence of COVID-19
This descriptive study examines and documents the WHO learning response in the early months of the pandemic by comparing epidemiological information and OpenWHO.org use in the countries with the highest COVID-19 cases. Statistical datasets from OpenWHO.org and the WHO's COVID-19 dashboard were overlaid for the period March 11 to May 22, 2020. During this period, for most of the 24 countries with the highest COVID-19 cases, platform use showed a corresponding trend. Courses published in the official languages spoken in these countries were utilised, indicating a need to produce materials in languages spoken by affected communities.

Study IV: Online learning for mass audiences during the COVID-19 pandemic: Key considerations for real time information dissemination

This paper introduces online learning related key considerations for asynchronous health information dissemination during the COVID-19 pandemic. The findings were based on 1.5 years of real-time massive scale learning interventions during this public health emergency. The article content comprised of meta-data analysis on OpenWHO; and literature from the same time on health emergency learning interventions was explored. Statistics-driven findings were made based on the open-source learning platform OpenWHO use case and scientific literature from similar recorded experiences. The paper presents analysis from the recent literature and couples it with the real-time pandemic learning response results.

2 LITERATURE REVIEW

The concepts and themes of this research are explored through the literature and include massive open online courses, health information and health information literacy, information dissemination models and expert-led learning formats.

2.1 Massive open online courses catered for in asynchronous formats

This research focuses on learning and information dissemination in informal, voluntary settings through online means. Self-directed, self-paced learning falls under the category of informal learning as shown in Figure 1 (European Commission, 2016). These activities are not necessarily institutionalised, they are less structured and can take place almost anywhere.

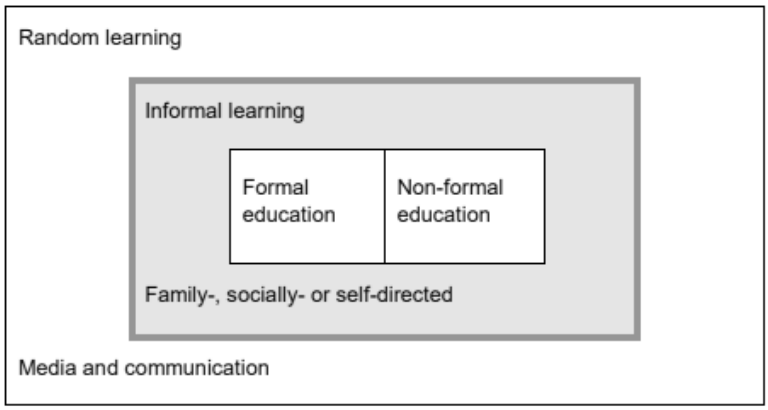

Figure 1. Scope of Learning (Adapted from European Commission, 2016)

The word e-learning was first introduced in 1998, the same year that Google was launched (SH!FT, 2015). Online learning refers to the use of digital materials to support learning (OECD, 2020). The Oxford Dictionary (2021) refers to e-learning

as "*a system of learning that uses electronic media, typically over the internet*", but does not refer to online learning. These terms are often used interchangeably. In this research, the term "online leaning" is utilised throughout for consistency as it is part of Massive Open Online Courses (MOOC) terminology.

COVID-19 is the first pandemic of this severity to occur in the era of online teaching and learning. The approach in this thesis is that of asynchronous information and learning dissemination in which learning occurs in online educational environments without teacher and student interaction as an intermittent communication and only in self-paced formats without learners interacting at the same time (Carr, 2012).

While the studies and literature often refer to degree-building MOOCs, the MOOCs in question in this research are those which are freely accessible without cost and disseminated openly, not part of a degree programme or certification system.

This research focuses on the informal, voluntary learning dissemination in massive, online formats through MOOCs. MOOCs were first introduced in 2008 and have since grown into a large, globally encompassing intervention (Downes, 2010). There are arguments that the first true MOOC was by Sebastian Thrun and Peter Norvig in 2011 on an artificial intelligence course at Stanford; a course which attracted some 160,000 online registrants (Porter, 2015).

MOOCs have existed for more than a decade and have provided completely new ways of learning for everyone who chooses online learning. While online learning does not necessarily need to take place at a distance, in this context it will refer to distance, non-personalised, dispersed online learning. The number of enrolments for online courses on degree-producing platforms such as Coursera, edX, and FutureLearn reached 180 million by 2020, with one third of all learners that ever joined a MOOC platform did so in 2020 (Shah, 2020).

MOOCs have been divided into three distinct types of MOOC category (Beaven et al., 2014):

- xMOOCs, eXtended Massive Open Online Courses, that are content-focused and expert-driven, from one-to-many models, for scalable learning.
- cMOOCs, connective Massive Open Online Courses, are networked, self-organised and strongly peer-to-peer formats for learning.
- Hybrid MOOCs are community- and task-based social learning, that emerge in free formats and spaces from the authors.

This research focuses on xMOOCs, where, per Beaven et al. (2014), the xMOOCs have a strong focus on the content transmission and acquisition feature. They utilise the instructivist approach where expert instruction plays the major role, and the course has automated assessment. In xMOOCs, learners can take and complete the courses without any participatory elements. The xMOOC format is not limited and could include opportunities for networking, such as discussion forums and joint task completion. Mazoue (2013) suggested that the xMOOCs can optimise the learning through highly defined and composed online content materials that are accompanied by assessments.

According to Martin, Sun and Westine's (2020) systemic review on most recurring online teaching and learning, research themes in 2009-2018 were far from learner engagement (28.92%), learner characteristics (21.64%) and all other topics including learning technologies, design and development, learning outcomes and institutional support were about 5% of research topics each. Impact and learning outcomes of asynchronous learning are not largely weighed in the current xMOOC research. Most research into online education is related to topics content resources, inputs and student views and attention is mostly on designers, employers, and clients' views and evidence for output- and outcome-oriented approaches (Martin et al. 2020; Esfijani, 2018).

The rise of MOOCs has brought learning providers from institutions and companies to produce courses for their needs. Ossiannilsson et al. (2015) suggest that institutions perform differently based on which stage of learning provision they are in: early, developing, mature or evolving. The maturity level affects the learning outputs and different considerations for quality assurance for appropriated design and approval of learning programmes, public information aspects and ongoing monitoring and periodic review of programmes is suggested accordingly. Further, identified key elements affecting quality culture in online education are communication, trust, collaboration, inclusiveness, innovation, and commitment (Ossiannilsson, Altinay & Altinay, 2015).

The COVID-19 pandemic hit at a time when internet penetration and use of internet-based solutions via various gadgets, was higher than ever before. Evidence deriving from the OECD (2020) states that web searches on training online increased into four times higher in March-April 2020.

Learning and education were among the principally disrupted sectors during the COVID-19 pandemic but at the same time, the online means provided a continued

manner of staying active and learning for those who had connectivity and means to connect (UNESCO, 2020). Fortunately for those eligible and privileged with access and means, the online learning offers options for quality learning for large audiences (Dhawan, 2020). According to Thakur et al. (2021) the increased design thinking can improve significantly virtual learning methods, innovative new curricula and rapid dissemination of information. Orey et al. (2020) presented that the course management systems and platforms are primarily used for information dissemination where any conceptions of teaching play a lesser role.

Finset et al. (2020) summarised that a global pandemic situation requires a broad, interdisciplinary response in which "*professionals in the fields of communication, education, and health behaviour change need to take responsibility for carefully evaluating what is known and insights currently emerging*". Open media and materials of the internet have the power to enable wide dissemination, but also pose risks such as misinformation. Recent research has highlighted the need to leverage health communication to help fight the COVID-19 infodemic (Mheidly & Fares, 2020; Reddy & Gupta, 2020) in which the role of the authorities is to lead in conceptualising and contextualising the health information. According to Paakkari and Okan (2020) COVID-19 has shown that health literacy could help people to understand science and make related choices and decisions.

2.2 Health information and increased health information literacy as an outcome of learning

For the purposes of this thesis, health information is seen as information that is vital in health emergencies that threaten local or even global health security. The provider of this type of information is usually a trusted health authority and the receiver may be a health worker or even a more general audience including health decision-makers, planners and implementors on different levels. Second, public health organisations and practitioners can learn to adopt more effective strategies to improve the dissemination of health-related information and recommendations.

Health workers have different reasons to search for health information. Williams et al. (2011) classified those reasons as being confirmation or rejection of the existing knowledge, assistance to solve a new or unusual healthcare issues, or a basic

knowledge update on a specific subject through review. According to Pakenham-Public health workforce need readiness and affirmation of their organizations capabilities to function in emergencies including clarify of their own roles (Gebbie & Merrill, 2002; Walsh & Bukachi, 2009).

The researchers of emergency healthcare have proposed that thorough information dissemination and cross curricular teamwork are required for a functioning response system (Mansell & Curry, 2002). Building and sharing knowledge are crucial elements to enhance productivity and competitiveness while preserving conventional memory (Laycock, 2005) and open-source information dissemination and use of communication technologies (Mansell & Curry, 2002).

Information plays a major role in emergency situations and therefore, the capabilities to search, evaluate and use the information are crucial. The concepts of information literacy and health information literacy give the conceptual context for the information dissemination in the health emergencies. Feather and Sturges (2003) defined information dissemination as "active distribution and the spreading of information of all kinds".

The concept of health literacy was first used in 1974 (Simonds, 1974). Ever since, the domain has expanded across the health promotion, health education and related fields, though health literacy as a subject is newer (Peerson & Saunders, 2009). Sentell et al. (2021) presented that health literacy research are based on following principles: "*1) defining health literacy as essential skills and situational resources needed for people to find, understand, evaluate, communicate, and use information and services in a variety of forms across various settings throughout their life course to promote health and wellbeing; 2) enhancing health literacy in populations and systems is critical to achieving health equity.*"

The ability to plan and make informed decisions during a health emergency is fundamental to protect one's health. According to the European Health Literacy Consortium (Sorensen et al., 2012), health literacy entails four types of individual competencies from accessing to understanding to appraising and lastly to applying.

Information literacy is a library-area driven concept for information seeking and using information skills. Tuominen et al. (2005) have presented information literacy as a sociotechnical practice, that needs to be understood in "*the interplay between information technologies, workplace learning, and domain-specific knowledge formation"*. Doyle (1992) has suggested information literacy to involve the ability to access different sources of information using any kind of technology, to assess information, to organise it for constructive use so that information can be used in problem solving

and critical thinking. Lenox and Walker (1993) have proposed that information literacy is about critical and analytical skills to develop research queries and analyse the results by people themselves. The information literate person should have strong skills to search for and use different information types to make sure they get the information needed. These aspects are relevant for the information user profiling. This relates to Shapiro's and Hughes' (1996) suggestion that information literacy could be depicted as a "new liberal art" which goes beyond the ability to use technologies and access information to more profound and practical set of skills related to information processing.

A more recent perspective from Tuominen et al. (2005) state that information literate people are knowledgeable learners who already possess skills and competencies for the information absorption and describe information literacy as a context-specific concept that needs contextualised application.

Contextualising information literacy and information literacies for communities of practice in different workplace settings has been examined by Lloyd and Williamson (2008) and Lloyd and Talja (2010) and some systematic approaches on situated and domain-dependent nature of literacies were presented. Some other interesting information literacy related research has been suggested by Webber and Johnston (2000) which relates to personification of information based on a set of personal attributes. Among those attributes, someone who is information literate should be able to recognise the need for information and identify promising channels of information and be able to seek for information. Information literacy research in information studies is among the most popular topics according to Togia and Malliari (2016). The most common topics among 440 reviewed articles in the domain were information retrieval, information behaviour and information literacy.

However, a combining concept has also been seen as useful in the literature. Health information literacy sets the information literacy abilities in the health context in a pursuit to make good decisions. Health information literacy defined by Medical Library Association (2003) reads: *"a set of abilities needed to: recognize a health information need; identify likely information sources and use them to retrieve relevant information; assess the quality of the information and its applicability to a specific situation; and analyse, understand, and use the information to make good health decisions"*. As such, the concept combines the most important aspects of both information and health literacy.

Enwald has studied the nexus of information studies and health communication in several pieces of research (Enwald, 2012; 2013) and concluded that objective data

should is needed to tailor health information and stated that different feedback message strategies should be adopted in different contexts. The research provided that generalised health communication is not enough to change a person's health behaviours and to meet the information needs of targeted populations. The research utilised intervention studies and examined health information behaviours, and the studies provided important evidence for information presentation and how to measure the uptake of health information dissemination. Enwald (2013) has also stated that health information literacy is a foundational approach for tailoring health information.

2.3 Models for information dissemination for mass audiences

There are several existing models for information dissemination also applicable to the health emergencies learning dissemination. Researchers have introduced frameworks for information dissemination and transfer in contexts applicable to this research: Johnson and Case (2012); Green et al. (2014); Seeger et al. (2018); Graham (2016); Greenhalgh et al. (2004); Duggan (2014) and Ward et al. (2009). During the pandemic, some novel models emerged.

Johnson and Case (2012) introduced information carriers, where a focus on channel selection and usage is introduced in the context of health information dissemination. The salience of channels is segmented and specialised according to the functions of the information seekers. According to Johnson and Case, the usage and selection of any channel of information and communication is contingent to what role the channel is performing for the information seekers' needs. Some modelling for health information dissemination was presented by Johnson and Meischke (1993, p. 345) in their model for information seeking for cancer in magazine-based sources. The trust in the information sources was seen to influence the health information behaviour change. A newer adaptation of the same model was applied to online health information seeking in India by Basnyat et al. in 2018 and informs the research scope at hand. Basnyat et al. have based and adapted their model based on the one of Johnston and Meischke, where the information carrier

factors are divided into characteristics and utilities. The 1993 original model has antecedents of background (demographic and direct experience) and personal relevance (salience and beliefs) that all relate to the information utility. In the online health information seeking model (Figure 2, Basniat et al. 2018, page 4), the antecedents are more widely adjusted to today's information landscape and include elements of media use and personal background.

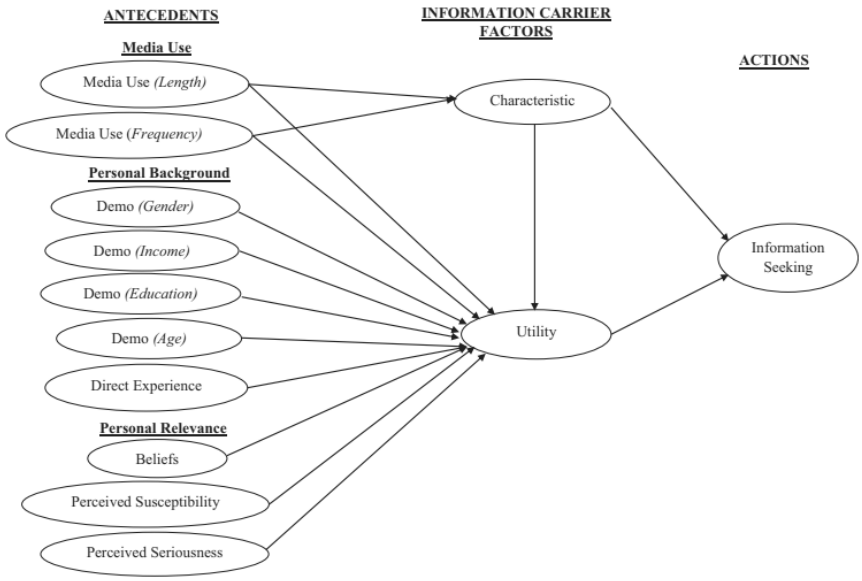

Figure 2. Adapted comprehensive model on online health information seeking (Johnson and Meischke 1993 model adapted by Basnyat et al., 2018, p 4.)

Another interesting and adaptable framework for this research scope is by Green et al. (2014) who developed a diffusion theory for public health knowledge dissemination. It presents conceptualisation informed by research on the production and transfer of information from research to practice and policy. The framework was put together to ensure relevance, and fit the research to the needs, circumstances, and populations of those subject to the practice or policy applications.

Another conceptual model developed specifically for evaluation is by Seeger et al. (2018). This is for evaluating public health emergency risk communication (ERC)

and was developed together with the United States Centers for Disease Control and Prevention (CDC) for assessing emergency risk communications. Duggan and Banwell (2004) presented a concept of information dissemination in a crisis and conceptualised provider and recipient aspects. Ward et al. (2009) presented a systematic way to develop a framework for from knowledge into action which was formed after a larger thematic analysis of the literature and led to a conceptual framework process that include steps from problem identification to knowledge utilisation. Graham (2016) provided a similar action cycle for knowledge creation and added the outcome evaluating and sustaining the knowledge use.

Greenhalgh et al. (2004) provided a model for innovation dissemination. In their findings, several system antecedents for innovation were presented in the nexuses of innovation, diffusion, dissemination, implementation, sustainability, adoption and assimilation. Diffusion is about passively spreading informal, unplanned sharing. Dissemination is active and involves planned efforts to enhance uptake of information. Assimilation is when the unit of adoption is not an individual, but a more complex and broader system or organisation level adoption. An innovation spread model in service organisations presented is in nexuses of where the information spread happens (Figure 3). According to the model, the "Make it happen" outcome needs scientific, orderly, planned and programmed systems. The mechanisms for information dissemination are technical and managerial and the metaphors for spread are dissemination, cascading and re-engineering.

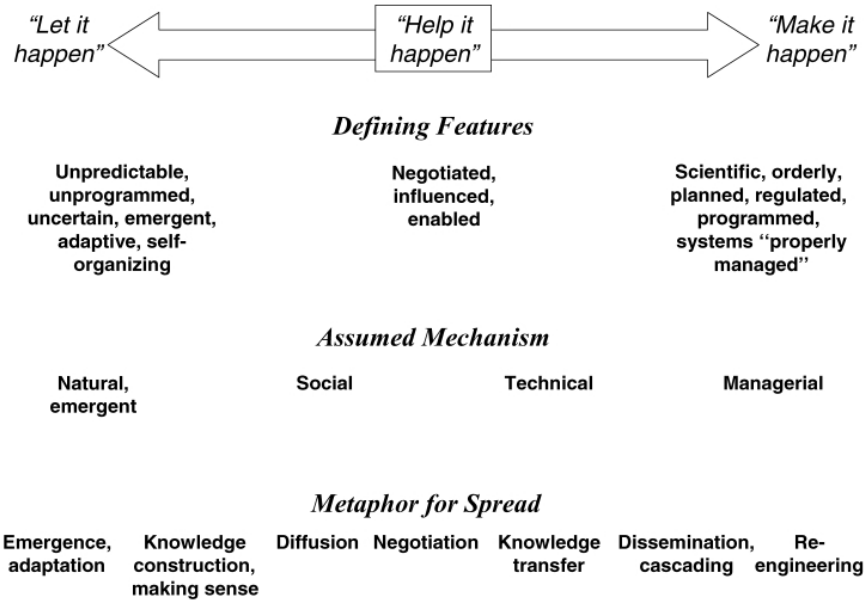

Figure 3. Different conceptual and theoretical vases for the spread of innovation in service organizations (Greenhalgh et al., 2004, p. 593)

The central premises of these models for information dissemination inform the research work at hand. The models presented by Johnson and Meischke (1993) and further elaborated by Basnyat et al. (2018) have informed the design of this research. The data extraction and elaboration for this research is aligned with the antecedents of media use and personal background. The surveys in the research have aimed to collect information on the personal susceptibility and absorption of the information received. The information carrier factors build the basis for the key requirements for health information dissemination from both utility and characteristics perspective in this research.

The models of Green et al. (2014) and Seeger et al (2018) feature elements of importance such as the circumstance factor for the information dissemination and contextualisation of the health information, both captured in the key requirements for health information dissemination in this study. The information dissemination in these contexts is considered as an intervention to help curb transmission of infectious disease pathogens in an expedited manner. The Graham's sample of knowledge creation informed the evaluation of the knowledge use in this research.

These models include shared advantages that have helped to clarify the scope of emergent, instructivist information dissemination through online means on OpenWHO platform. Self-paced MOOCs on OpenWHO were considered as a choice for the massive health information dissemination for infectious disease outbreaks and health emergency situations as technical and managerial dissemination (Greenhalgh et al.,2004) that needs to happen in the epidemic pandemic setting.

Drawing from the models that have enabled this research to focus on key aspects such as reach, use, access and usability of the xMOOCs and have helped to establish key requirements in a format of frameworks open for use by anyone in massive scale open-source and scalable information dissemination.

2.4 Instructivist and prescriptive learning

This thesis aims to introduce a framework that suits asynchronous, one-directional, authority originated information from the learning provider to the learners, as a necessary act in emergencies to disseminate critical information and therefore, save lives. The research theories relevant to this research are the learning related instructivist theory and theoretical frameworks for information dissemination. Elements of the diffusion theoretical models' application were discovered in the literature chapter. The targets of the OpenWHO learning interventions are adults. Therefore, foundational adult learning principles need to be visited to appropriate the focus on adults. This section elaborates how andragogy, the method and practice of teaching adult learners, was considered in this research. The word andragogy derives from a Greek word "andra" meaning man or adult. The definition of "andragogy" by Knowles (1984) refers to internally motivated and self-directed, goal- and relevancy-oriented and practical learners, just like the ones that come to the modern time asynchronous learning journey online, in self-paced spaces.

Instructivist and prescriptive learning is expert- and knowledge-led, a process of forwarding and sharing the existing knowledge in one direction (Onyesolu et al., 2013). In the instructivist approach, the knowledge is understood as a gift – unlimited material that learners receive and is often referred to as a teacher-centred learning environment.

The opposite of instructivism is constructivism that sees the teacher not at the core, but more as a facilitator, who provides an enabling environment for the learning process, pairs students with peers and students to create their own knowledge and even stipulate their learning pathways (Freire, 1984; Dewey, 1997).

Constructivism is a learning theory in which each learner constructs their own knowledge. Similarly, prescriptive learning (Williams et al., 2011) in its essence is centrally controlled by experts, the modality of conveying it is hierarchical. Williams et al. (2011) stated that it can be replicated and transmitted at scale to users, just like the WHO's OpenWHO does, for well-determined reasons. The evidence is packaged into formats best suited; information is predictable and is in demand from the users. Instead of the needs assessment, the learning provider stipulates the content requirement based on the situational needs of large-scale audiences, not by inquiring individuals.

Access to up-to-date guidance can be facilitated through asynchronous learning delivery. Based on these findings, it can be seen that xMOOCs, with their one-directional and instructor-led approaches, can work for the purpose of mass dissemination as a critical first knowledge component.

The opposite to prescriptive learning is emergent learning, which is adaptive, distributed in nature, collaborative and self-organised. The creation is by users. In health emergencies, the instructor-led and instructor decided materials provide for structured and controlled learning content. The learner has less autonomy and self-directedness, but the choice of learner on what and when to learn is still there. In these prescriptive pedagogical choices, the learning is about receiving content as per the teacher defined goals. Transfer of knowledge is knowledge that comes from the instructor to the learner (Beaven et al., 2014). The instructivist and prescriptive learning approach is a much-argued area due to the emphasis being on the instructor-led learning.

According to Blasche (2012), pedagogically speaking, the instructor controlled, directed and determined learning provides low reciprocity and therefore is not engaging enough for the best learning outcomes. This instructor-centred approach has been criticised for its regressive nature (Rodriguez, 2012), and not only in online learning – also more generally as a teaching method which does not allow space for the learners (Herrington & Standen, 2000; Mackness et al. 2013).

Even though xMOOCs have been criticized as top-down and authoritarian, they may serve the purpose of instant, rapid, fast and frequent information dissemination.

Prescriptive learning may not work equally well for sudden onset epidemics and long-lasting contexts like pandemic. The massive scale learning response is well placed to begin with the self-paced asynchronous and instructivist delivery of health information as the science emerges and evolves. It is especially in this context where new evidence is added to the health information dissemination through online learning means.

2.5 Concluding chapter summary

The literature gives relevant and important aspects to consider for online learning as a mass modality, how MOOCs have developed in self-paced modalities, and the benefits of online learning in information dissemination. The massive scale learning intervention interest in this research is that of continued education, where adults join the online learning voluntarily, based on their needs. The enablers and barriers relating to online learning programmes need to be revisited, explored in detail and contextualised so that any barriers endangering the online learning attendance and access to information can be effectively addressed.

The literature provides useful information dissemination frameworks and concepts to take into consideration when mounting a massive scale health information online learning platform and materials. The utility of these frameworks was revisited in the research and used where appropriate to inform the learning providers mounting an online, asynchronous learning response.

3 METHODOLOGY

This methodology chapter presents the research design choices made for the studies of this thesis.

This thesis explores online course provision and presentation in online learning formats in the setting of a global pandemic and some epidemics. As the aim of this thesis was to gain an understanding of the health emergency information dissemination through online learning means, all methodological choices were made based on the evidence accumulated from the OpenWHO platform.

The data acquisition both from the platform and the surveys inform recommendations on the usability of the platform and the materials within. The research methods in the original publications referred to in sub-section 3.1 support the examining of MOOC use during epidemics and pandemics.

All data and evidence outputs were analysed utilising the thematic analysis approach and were coded into emerging themes of importance. The thematic analysis research approach as detailed in sub-section 3.2 supports the processing of the data evidence and results accumulated into a structured format of key themes in massive scale online learning through asynchronous formats.

The research theories referred to in sub-section 3.3 support achieving the research objectives by understanding the results of the studies and elaborating them into findings and eventually into generating the frameworks of requirements for the platform aspects and packaging of the learning.

3.1 Research methods in the original publications

The research is longitudinal as the collection of data for the articles was collected at multiple points in time during 2019 to 2021. Studies I, II, and III provide general practice implications that led to building of the analysis-based Study IV and laid a foundation for the framework development proposed in the Study IV. IV can be seen as the collating and finalizing stage of the research project. The third and fourth

articles reflect some degree of user-driven adaptation and access and use in various regions of the world. The four articles mirror the chronological evolution of OpenWHO.org in epidemic and pandemic learning response during the years 2018-2021.

The four original publications include topics, data scopes and timeframes as illustrated below (Table 1).

Table 1. Original publications and their topics, data scopes and timeframes

Study 1	Study 2	Study 3	Study 4
Evidence from one epidemic response	Evidence from first 3 months of pandemic learning response	Evidence from pandemic surge and use of learning materials	Evidence from 15 months of pandemic learning response
Ebola Virus Disease online occupational health and safety course use, locations, occupations and motivation of users	1st COVID-19 introductory course and global use thereof at the onset of the pandemic	10 COVID-19 course topics in multiple languages, their global use combined with the burden of COVID-19 disease	Global findings of pandemic learning response and a supporting literature review to inform practice
Course related platform data 2018-2019 and survey data from 2019	Platform data on real-time learning response in January-March 2020	Platform data March-May 2020 overlaid with same time global incidence of COVID-19 per WHO epidemiological data	15 months of platform data and 2 learner surveys during January 2020-March 2021 and literature review informing practice of the platform operations

COVID-19 courses related findings are a major part of this thesis and are presented in three of the four original publications. One article is based on Ebola Virus Disease course findings. All courses presented in these studies are self-paced, disease-related courses from WHO experts to anybody willing to access them. The studies include both quantitative data extractions from the platform and three qualitative surveys administered for learners. Original data was collected from the OpenWHO platform.

In the four original publications, the data methods are similar and include OpenWHO extraction. All studies utilized the descriptive analysis approach. The analysis is based on quantitative data collected from the OpenWHO integrated statistical data and analytics reporting system, an anonymized built-in reporting system on metadata of the platform use. It includes enrolment trends, completion

rates, certificate attainment, course statistics, active sessions and languages used. OpenWHO course reports include course-specific learners' performance and course activity indicators such as module completion, return rate, and data of use of videos, self-assessments, downloads, activity status, quiz performance, and obtention of the certificate, as well as tracked average session duration and time-stamped activity usage patterns. This information exists on all learner's performance and informs the usability of the courses that have been collected and analyzed.

Other key course performance related metrics with key outcome variables of interest were learners' locations and languages used, as well as self-reported data on gender, age, language preference and affiliation that is acquired at the time of the registration. User patterns and locations were analysed based on the OpenWHO platform's statistics and Google Analytics, and datasets were overlaid. Microsoft Power BI tool was used to analyse the data. Course registration and completion data captured by the OpenWHO analytics systems were analysed to understand user demographics, certifications, and dropout rates. Completion of the course was defined as watching all videos and completing the post quizzes with a score of at least 80%.

Additionally, three surveys are referred to in the studies that led to this thesis. The surveys aimed to capture the characteristics of the audiences reached by Massive Open Online Course (MOOC) and inquired more detail information about the socio-demographics characteristics of learners capturing gender, age, location, professional affiliations, language of preference. They also aimed to capture the user's motivation for enrollling to the courses and collect feedback on the course quality including learning needs being met and on course content to better understand usability and learning experience, utility, use case, motivation to join and any strengths and weaknesses of the courses. The learner feedback surveys were composed of approximately 20- 25 questions and surveys were implemented on the OpenWHO platform.

Survey on Study I is presented in the article on page 5. A user survey was sent to all active Ebola course users through a platform course announcement. The survey received 706 (606 in English, 100 in French) responses on user motivation, learning needs and level of comprehension were further analyzed to understand the use case and how the course was perceived by the users. The generic user sentiments were collected through the feedback in the open comments of the user survey.

Surveys on Study IV refer to two similar surveys for learners that were conducted during the first 3 weeks of March 2021 (365 respondents) and 3 weeks during March -April 2021 (2019 respondents). The surveys captured information on motivation to attend the courses, course contents and the satisfaction, the usability and online learning experience, as well as enabling and hindering factors for attending the online learning and these courses. The results are elaborated in Study IV.

In Study II the data relied on OpenWHO course metrics on use of the same course in different languages in different countries and looked at the language use by national and official languages of the countries. In Study III the OpenWHO data was overlaid with other information, such as epidemiological information and language maps. These data choices were feasible and provided comparable, aligned materials from the platform in focus of this research.

Table 2. Summary of research topics, data collection and data analysis in the original publications I-IV

Study	Data collection	Data analysis
I	Data metrics from OpenWHO platform and Google Analytics. Survey for learners.	OpenWHO and Google Analytics datasets were overlaid to inform on the use. Survey analysis responses were analysed.
II	OpenWHO data metrics for same course in 13 languages	Descriptive statistical analysis was conducted based on user location, and data disaggregated according to the six WHO regions, the top ten countries with the most users, and the use for each language version.
III	OpenWHO data metrics of courses in 22 languages. Statistical datasets from the WHO COVID-19 dashboard on epidemiological situation.	OpenWHO datasets of courses accessed in different languages were overlaid with the same time epidemiological datasets from countries with the highest number of COVID-19 cases. Descriptive analysis was conducted to assess course use in languages of the countries in countries with the highest burden of disease.
IV	Data metrics of OpenWHO platform. Two surveys.	Descriptive study analysis data was analysed using Power BI and survey data was analysed using Microsoft Excel.

The research utilised the meta-data findings over the two years, all collected in the same manner from the same platform, making the material measurable and comparable. The utilisation of similar data points also provided that the research

scope can be replicated, and data saturation was researched by the end of Studies I-III. As there was a repeated pattern of data and there was no novel information provision from the data, with data showing repeated patters and redundancy signals (Morse et al. 2002). According to Morse et al., data saturation takes place when there is no new information emerging and the researcher can confirm that further data would continue to give similar results. The data saturation point in this research was reached in the thematic analysis stage, when the OpenWHO data was organized in categories and showed repeating patterns and re-emerging themes.

3.2 Research design and approach of this thesis

The research philosophy used for this thesis was interpretivist and exploratory, as the study arises from the work area which the researcher has developed and led from the launch of the OpenWHO online learning platform. The interpretivist, exploratory approach (Creswell, 2009) was used in the research journey that involved data handling, formatting into results, and led to a development of frameworks that are grounded in the data evidence which was collected and presented in epidemic and pandemic contexts. The research is based on qualitative methodologies and the research aims and objectives are exploratory in nature, as they are not testing a hypothesis or concept, but building a framework.

This study depicts the data results of the platform, and while doing it qualitatively and descriptively based on data and analysis results and findings, the interpretation of the data was subjectively done, in an inductive process, with open-ended questions and in a process-oriented way.

Dudovskiy (2018) provided that the reasoning of the quantitative methods is most often that of induction, meaning and subjectivity. The research questions were open-ended and process oriented. The research was inductive, where the data and observations were generated based on the four publications produced over a period of two years. With the inductive approach, as suggested by Goddard and Melville (2004) and Bernard (2011), the work starts with the observations which result in theories or frameworks based on the findings and observations.

Alexandridis (2006) provided the attribute to inductive studies that are labelled with the bottom-up approach, spatial, cognitive and temporal scales are multiple, and the data intensity is very high. He labelled the inductive study focus to be that

of understanding dynamics, robustness, emergence. These characteristics were deemed relevant to this study's research process.

3.2.1 Thematic analysis approach

The research strategy builds on qualitative thematic analysis. Original publications have been used to inform the background information for this synthesis. When choosing the research analysis type, both thematic and content analysis were considered, but thematic analysis was chosen as it employs a descriptive approach in coding and interpretation of data (Downe-Wamboldt, 1992). Content analysis or quantitative analysis could have been done, but these would not have fully responded to the research questions and the types of data generated in the original publications.

While authoring the articles, the findings were emerging from the big data. Therefore, the researcher had no preconceptions regarding the data. On the contrary, coding was used to give meaning to massive scale data that varied between ten different disease materials, with the bulk of it being on COVID-19. An inductive thematic analysis was chosen in order to allow the themes evolve from the data. The researcher followed this approach thereby choosing to derive meaning and create themes from data without any presumptions, with the findings emerging from the data freely (Nowell et al., 2017).

The thematic analysis provides scrutinised picture of data that is in hand from the authentic publications on OpenWHO. The thematic analysis works on various sources, both qualitative and quantitative and has become its own analysis model, not a mere sub-section to grounded theory or other modalities of research approach (Braun and Clarke, 2006). They have also provided guidelines for different styles of analysis even though they have acknowledged that there are different ways of performing the thematic analysis. For instance, King and Horrocks (2010) have suggested matrix and framework analysis. While both matrix and framework analysis could have been interesting choices for this research, the data and evidence gathered spoke for a need to find a suitable analysis for the material that had a qualitative analysis research approach, while the data informing the dissertation is both quantitative and qualitative. The thematic analysis is the best fit of all options available.

The researcher worked through the reflexive thematic analysis as the type of inductive properties approach that creates the code in the latter part of the research and is a typical example of inductive coding. As thematic analysis was chosen, the focus was on collecting the key informants from the data over the four publications, with relevance to the research problem.

This thesis searches for patterns from the observations in the original publications. As the work on generating the data and evidence is what started this research journey, the researcher had no theory or hypothesis to test in the beginning of the research process, but theories were used to frame the findings and build a new framework to inform practitioners and policy.

3.2.2 The thematic analysis process

Steps in the thematic analysis process include familiarisation, data coding, merging and evaluating key themes, providing names for the themes and compiling a report (Nowell et al., 2017). The researcher first familiarised herself with the data and kept a reflexivity journal, where she noted dozens of code elements deriving from the four studies. She then coded all the research topics that provided interesting and important input to inform the specific requirements for global scale online learning for mass audiences. This enabled the researcher to gather codes very systematically and display the meaning of a code in all studies' datasets.

The coding was further organised into summaries of important themes. After several rounds of processing the codes, they started to form patterns and themes around the research questions. This qualitative coding process (Table 3) led into ten broader themes that are key considerations (Chapters 4 and 5). The themes emerged in a repeated manner throughout the publications. The researcher had to rework and review the themes and adjust them into several different categorisations. A step was taken to verify that the themes identified were fully relevant to the research objectives.

Table 3. Thematic analysis process

Category	Definition	Coding rules
Key considerations	An overall consideration of a theme that merged from the research materials	Themes were collected and merged into overarching themes forming a consideration
Target	An overarching definition for the goal related to the consideration was established	Codes that supported direct achievement of the given goal were listed
Value	A value proposition aimed at the consideration was defined	Codes capturing the information provider's desired value proposition were established
Means	The major converging means of how this consideration can be achieved was captured	The actual actions supporting the outcomes were coded
Measurement	An immediate requirement on how to measure the outcome	Codes seeking to define elements based on which the consideration can be measured were used

The convergence of the topics led into two clear topical categories of key considerations. The categories respond to the research questions on online learning platforms and the learning material packaging requirements. The two research questions were fully independent, and not upper and lower level compared to each other, and emerged from the thematic analysis. The thematic analysis provided equal importance to both, and they are also very distinct in terms of the different natures of the themes that are not interdependent. For instance, the packaging is not platform requirement driven, but packaging can be done without the platform. Platform dissemination can be done without a certain type of a material packaging.

The outcomes of the thematic analysis are presented in Chapters 4 and 5 which also present the frameworks that were developed. The latter part of the work included finalising the themes, elaborating on the means of verification and examples of values that drive them and other elements of the frameworks, as discussed in Chapter 5. As the thematic analysis was carried out following the inductive approach, the work could only be done in a bottom-up format and aimed to produce results in the form of a theory of framework.

3.3 Methodological limitations

The evidence is based on surveys and statistical data collected and extracted from the OpenWHO platform's built-in reporting system that has static data from the learner completion and performance and on users' self-reported background information. The reliability of the results has been considered throughout the data collection and the results from the learning platform are reproducible and stable. The data collection sources were the same and data was collected with the same data variables and in similar measurement ways. As interviews or other qualitative data entries were not collected, the data was precise for the purposes and is replicable.

The thematic analysis stage that was drawing findings from the research studies, was a qualitative process. The standardisation of the conditions could not be simply guaranteed, as the definition of features collected was a choice by one researcher. However, the same process can be replicated in other contexts. As the data collection methods provide measurable and comparable data, a high level of validity can be ensured. In the survey questionnaires the same patterns of access and needs were utilised throughout, and questions were based on industry standard online learning learner surveys. The surveys were voluntary, and the bias might be in representation, where only the most motivated attend. To achieve valid and generalisable results, the same sampling methods for data were used (Nowell et al., 2017).

There could be data collection bias as the collection is limited to what is possible on the platform, and measurement bias in that the researcher worked on the platform and could pick and choose data for the research. Personal data preferences and those of survey preferences might cause bias. The same applies to analysis bias, where the data processing has been done from the operational research requirements point of view. Further, in the thematic analysis, as the researcher is subjective to the data and findings, her focus might have been easily diverted to the data samples that confirm her own thoughts and expectations, thus the data could be seen favouring her research interest. To try to mitigate this, the researcher paid careful attention to subjectivity issues that could impact the research.

The researcher worked as the platform manager providing a high level of subjective choice in research topics and aspects. The researcher also worked on the thematic analysis and on the codes and themes alone. The subjectivity is likely in thematic analysis, in which the judgement is with the subjective coder, and in this case, a coder that is very familiar with the platform raw data and the use case. That

having been said, there are also positive implications, those of tacit and inner knowledge of the platform and its performance. A limitation is reliability in the interpretation of the data into the themes and categories. It is possible that the researcher may have omitted some data and equally may have expanded the meaning of some codes, even if their meaning might not be comparable to the other themes that emerged. The researcher aimed to build on the data evidence only and rely on the data accumulated in the four original publications. The replicability of work can be done through constructing a similar coding process for other source materials. The work going forward would require testing of the themes in a new emergency or acute event and in the open-source information dissemination context.

The methodological choices of this research have determined how the data findings were turned into results. This was further elaborated through the theory and literature references into a discussion in which two thematic analysis driven frameworks were emerging. All data presented in the research is based on the original publications. This study is designed to be readable without the reader needing to go to the original publications.

3.4 Concluding chapter summary

The methodological choices of this research have determined how the data findings were turned into results. This was further elaborated through the theory and literature references into a discussion in which two thematic analysis driven frameworks were emerging. All data presented in the research is based on the original publications. This study is designed to be readable without the reader needing to go to the original publications.

4 RESULTS

The primary goal of this research was to address which key enabling factors provide equitable learning for mass audiences. The results are elaborated from the thematic analysis process, in which codes were drawn from the original publication to establish synthesis. This research aimed to determine which online practices contribute to reach in a global information dissemination context and established key requirements for an asynchronous online learning platform and digitalised learning materials packaging to achieve a globally reaching learning response in a health event. The evidence is from the OpenWHO platform.

This results chapter provides data and evidence on a total of ten thematic areas that emerged from the data relating to the open access platform requirements. The results derive from the original publications. The thematic areas are organised into two larger categories, one relating to platform requirements and one on learning material packaging. These results are all based on asynchronous, self-paced, real-time health emergency learning responses. The figures presented in this chapter reflect the original data referred to in the original publications. The original publications contribute to the thematic findings as indicated in Table 4.

Table 4. Original publication contributing to the research findings

Findings on platform requirements	Findings on online material packaging
Open access formats Publications 2, 3, 4	Real-time dissemination Publications 1, 2
Digital divide bridged Publications 1, 4	Learner-centric design Publications 1, 2, 4
Dispersed content creation Publications 2, 4	Language localisation Publications 1, 2, 3
Learner attendance and completion Publications 1, 2, 3, 4	Materials for underserviced groups Publications 2, 4
Importance of platform data capacity and findings Publications 1, 2, 3, 4	Content developed in fully adjustable and multipliable formats Publications 2, 4

4.1 Results informing open access global platform

4.1.1 Open access formats

To provide the adequate infectious disease knowledge to the world, OpenWHO together with the WHO expert teams, has developed more than 190 self-paced online courses and the platform covers 33 different diseases. During January 2020 – December 2021 OpenWHO published 40 COVID-19 courses to support various aspects of the response as the pandemic evolved. OpenWHO targets for practitioners, response teams, volunteers and decision-makers on the frontlines of health emergencies. As the platform is open source, any interested learner can join without any limitations as courses are educational also for the public.

The open access, low-bandwidth formats have allowed learners needing topical information related to different infectious diseases to access the materials. The disease courses showed use globally and in the outbreak epicentres. The OpenWHO data illustrates that courses on infectious diseases are used most in the locations of epidemics, regardless of what the OpenWHO use pattern is in the country otherwise. The access to the materials is active from all locations where the outbreaks have occurred, demonstrating the platform's open access and reachability regardless of the internet infrastructure. The demand for COVID-19 courses was highest among health workers and countries with the highest number of COVID-19 cases.

OpenWHO hit the first 1 million enrolments milestone on March 27, 2020, and further five million in March 2021 (Figure 4). Of all the enrolments, 82.51% were on COVID-19 topics.

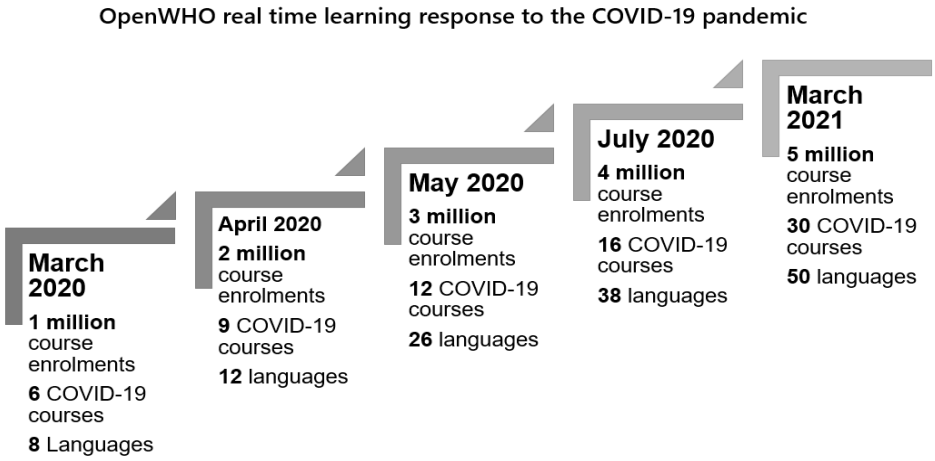

Figure 4. The pandemic learning response from March 2020 – March 2021

4.1.2 Digital divide bridged

OpenWHO data showed that the platform was accessed from everywhere in the world, per all 194 member WHO states. WHO territories brought a total of 0.65% of all platforms use during January to March 2020. The territories list (WHO, 2021) includes several of the world's most remote locations including small island states. When population factor is accounted for, 13 islands are placed in the top 20 list of enrolments per capita. OpenWHO use during the first six months of the pandemic resulted 11 out of the 13 countries that were new entrants into the top 24 list were from the Global South.

Learners from low- and middle-income countries increased from approximately half of the OpenWHO users in 2019 to 75.00 % in 2021. This increase was driven by the rise in overall enrolments from middle-income countries, which went from 40.20 % to 70.60 % during 2019-2021. At the same time enrolments from the WHO African region dropped from 14.21% in December 2019 to 4.00% by the onset of the pandemic in March 2020. Despite of decrease in percentage of all enrolment, OpenWHO results across the infectious diseases courses showed use in low-

resourced settings such as the Sub-Saharan African countries. Poster 5 provides visualization of this data.

The analysis on the infectious disease courses on Ebola and COVID-19 showed that there is strong evidence of the use in the countries of active transmission.

Ebola virus diseases courses showed high use among the responders in the outbreak epicenter in the DRC and neighbouring countries. In the DRC, where four Ebola outbreaks took place during 2017-2021, the use of Ebola ePROTECT, an occupational health and safety course, was most popular of all OpenWHO courses accessed from the country. In the global statistics, the DRC accounts for 17.20% of all enrolments to all Ebola courses.

A survey administered on OpenWHO asked about the barriers to attend the courses. While 56.00 % listed no barriers, the ones who indicated them, had particular issues with internet connection especially from those respondents from Global South, IT-related issues, time constraints and language. Annexed Poster 1 provides visualization of these data results.

4.1.3 Dispersed content creation

The OpenWHO platform content formats and production process enable the fully remote, dispersed and expedited publishing and dissemination of information. This is capacitated by the online material formats that are easy for the content experts, easy for the course producers and easy to update and revise. The learning design templates are self-explanatory for the subject matter experts (SME) and allow learning content creation and transfer in an extremely simplified process.

The OpenWHO platform and course production team, equally globally dispersed, have introduced processes that are easy to do and are easily explained. This is to ensure the best used of the SME's time which, in the case of the pandemic, is already compromised. The same remote process applies for all the translations, all done while being physically disconnected.

In the case of the introductory COVID-19 course, the WHO technical lead provided the relevant evidence content to the OpenWHO team to initiate the course production, verified the course content and recorded it. The OpenWHO platform published initial information on the novel coronavirus on 26 January 2020 after ten

days of production. The remote production modality allows all involved parties to contribute from dispersed locations. The entire course production and standards manual was put in concise format of ten pages.

As the WHO's disease-related science evidence and technical guidance contents are frequently updated, there is a need to implement the constant changes and revise the learning contents accordingly. The Introduction to COVID-19 course content has been revised 12 times. The technical lead has recorded the revised contents as a mobile phone voice recorded file and sent them to the production team.

OpenWHO's quick adaptation to the fully remote modes of learning material development during the COVID-19 pandemic has facilitated the production of 40 different COVID-19 course topics spread across 60 different languages in a record time, in fully remote and physically disconnected formats. A total of 1600 original instructional video products have been produced in English.

4.1.4 Recognition of learner completion

Overall platform completion rates on OpenWHO increased from 39.2% before the pandemic time (December 2019), to 54.20% in March 2021. Some courses reached very high completion rates, such as the health worker vaccine course in Spanish with 89.0% and Ebola GO pre-deployment course at 94.00%.

During the first year of the pandemic, the platform issued more than 2.8 million Completion of Participation (CoP) and Record of Achievement (RoA), thee latter providing that both course content and assessments have been completed at the minimum performance of 80%. A badge feature recognizing the course achievements was launched in 2021.

In March 2021, the platform hosted a total of 5 090 545 enrolments. Of the learners, 52.45 % took one course. On average, each learner completed two courses. There was a total of 75 105 learners who had completed more than ten courses on the platform.

When asked about motivation for completing the courses, surveys indicated career and continued learning as highest. In the vaccine courses the most frequent reason (35.3%) was career, followed by certification (11.4%), education (11.2%) and mandated learning (3.1%). For Ebola ePROTECT, the reasons were compulsory requirements (33.4%), increased knowledge about the disease (30.2%), protecting

oneself from the disease (25.7%) and strengthening the future employment or assignment qualifications (10.3%)

4.1.5 Platform data repositories

The OpenWHO platform's integrated reporting system included metrics related to age, gender, language, location, and affiliation of users along with course-based statistics such as the number of courses enrolled and completion rates. Anonymized statistical platform-wide datasets were utilized for detailed analysis of the platform data providing datasets on course, languages and themes. An inbuilt platform data system provided data overviews and snapshots and Google Analytics was used to capture OpenWHO activity by geographic location. All data was extracted anonymously and processed in the WHO Power BI tool.

As the learning content across the platform grew to more than 120 topics, the platform data provided information on the attendance to the courses and course completion rates and more information was collected through the pre- and post-survey questions on levels of knowledge retained. Data availability has made it possible to understand the use case, overlay the data with other datasets, such as the epidemiological data and other clustering such as the administrative areas.

Constant data monitoring gave interesting observations such as that the enrolment rate is the most prominent during the first four weeks following each course launch, whereafter it gradually decreases over. Big data handling becomes a task with the scale of dissemination OpenWHO has had since the onset of the pandemic. The survey based qualitative data collection is time consuming, expensive and requires processing expertise. The platform generic data can at best can help inform basic results of the learning provision.

4.2 Results informing online learning material packaging

These results informing on the online learning material packaging requirements and cover aspects related to the real-time dissemination, learner-centric self-paced

formats, language localization, packaging materials suited for underserviced groups and content development in formats that are fully adjustable and usable in multi-channel formats.

4.2.1 Real-time dissemination

Two Ebola outbreaks emerged in the DRC in 2018 and the first one was declared on May 8, 2018 and a need for a learning resource on occupational health and safety for deploying personnel was identified. The course, ePROTECT for Ebola, a health and safety briefing in a self-paced MOOC format, was published on OpenWHO on June 6, 2018, and was made a mandatory requirement for WHO deployments. This was the first course on the platform to be produced real-time for the deadly disease outbreak flare up in a country with remote and complex connectivity. The course uptake by September 2019 was high, including the high completion rate.

OpenWHO had an established expedited course production that was readily in place ahead of the COVID-19 pandemic, with the first novel coronavirus course launched in ten days of production, amidst scarce science and evidence as the first signs of the COVID-19 outbreak emerged. The course alone reached 1 million learners as of January 1, 2022 and is available in more than 50 languages.

Since the launch of this first COVID-19 course, the number of unique learners on the platform increased massively and the introductory course brough the largest number of new learners along with the Infection Prevention and Control for COVID-19 course. During January to March 2020, eight other COVID-19 course topics were launched in 13 different languages. Similarly, courses were accelerated for two vaccination courses in December 2020 ahead of vaccination rollouts that were imminently approaching at the time.

The platform use was highest in the regions where the number of COVID-19 cases were the highest when the Study 3 was undertaken in August 2020. During that time, of the 20 countries with the highest number of COVID-19 cases (i.e., 82.55% of the global caseload), 14 of those countries were also among the 20 countries with the highest OpenWHO activity levels. Posters 1 and 2 provide more insights and visualizations for these data.

4.2.2 Learner-centric, self-paced formats

Learner-centric materials in the OpenWHO context are video, audio, text, slide, quiz and html-format materials packaged into one learning course with all downloadable resources. The material format design was informed by the accessibility aspects formats as well as the necessity to regularly revise and update parts or entire course modules.

The formats of OpenWHO are modular videos that can be streamed and downloaded as high-definition or low-definition videos or as audio files for offline use. Learners can download all content, including videos and audios and separate power point presentations as well as transcripts and all materials can be shared in contexts without internet or computer access. Mobile application has same features for ease of use.

OpenWHO's health worker vaccine course learners identified videos and slides as their preferred learning formats in a survey. The least preferred format was collaborative spaces. The interactivity in the self-paced courses is compromised to mere discussion forums. Managing them is difficult with mass audiences, and discussion spaces have been enabled for some courses for the professionals to exchange with peers.

OpenWHO survey found that the top challenges to accessing learning are having time available to learn and the cost of enrolment, with women twice as likely to identify these barriers than men. The responses suggested that the top five challenges in accessing online learning in general were lack of time, costs involved, digital access, not knowing where to access reliable source, and language. The enabling factors were accessible, free, informative content and simplicity of use.

4.2.3 Language localization

In March 2021 alone OpenWHO translated nearly 1 million words and has translated more than 10 million words during the first two years of the pandemic. A vast majority of the courses are produced first in English, after which the translation into other key languages for the outbreak response is considered and initiated. UN languages (English, Spanish, French, Arabic, Russian, Chinese) were leading as top

languages on the platform and counted for 93.50% of the use. Following in popularity were Portuguese, Indian Sign Language, Hindi, Indonesian and Italian. In 2021 all other 36 languages on the platform accounted for 6.50% of course use. Spanish version of the Introductory COVID-19 course was overwhelmingly popular in May 2020 with more users in Spanish (51.50%) than the English course (39.67 %). Moreover, the findings demonstrated that users from the most COVID-19 affected countries in 2021 accessed the Introductory course in the official language of their country. The use patterns have shifted throughout the learning response.

In 2021 courses were available in 60 languages, including in the 15 most-spoken languages of the world and 27 languages selected to ensure reach and comprehension. Among the language offering, there were 14 African languages and the biggest uptake by numbers of enrolments of national languages was by learners in Burkina Faso, Burundi, Mali, Mozambique, Sierra Leone, and South Sudan.

When looking against the Least Developed Country (LCD) classification, courses exist in 42 of the languages spoken in the 44 LDC countries. OpenWHO courses aimed to deliver health information in several local and national languages of the populations impacted by the disease outbreaks.

DRC, which has been the country reporting the highest number of Ebola virus disease outbreaks since the disease was identified, is one of the top countries of enrolments in all five French Ebola courses. These findings suggest that the usage of the language versions of each course varies and there is a noticeable preference of users to access the course on a specific disease in the national language of their country. On OpenWHO, the Introduction to COVID-19 course was the most translated course and the French language was the most translated language on the platform. Annexed Poster 4 provides visualization of these data results.

4.2.4 Materials for underserviced groups

Previously less represented learner groups joined during the pandemic. The user group 70 years and older was not represented in the platform before the pandemic but increased to 4.59% of learners during the pandemic. The age group less than 20 years of age grew from 1.26% to 9.77%.

There was an increase in the proportion of women, the number grew from 40.14% before the pandemic to slightly more than 50.63% in 2021. Where prior to

the pandemic most learners were men, during the pandemic the learner enrolment was almost equal between women and men with some courses like the Infection Prevention and Control being led by female learners.

OpenWHO served the people with a disability, such as the deaf community for which the courses were offered using a sign language resource, produced in Indian Sign Language. It was used vastly around the world by 55 000 learners. Vision impaired learners are provided with audio and all downloadable versions and hearing impaired can reach all materials in text, slide and transcript versions. Annexed Poster 3 provides visualization of these data results.

4.2.5 Adjustable content

OpenWHO materials were in multi-use formats and produced in a modular structure to firstly enable course production teams to produce and learning content quickly. Secondly, these formats are also favourable for easy translation. Finally, these material formats are suited to being extracted and adapted to varying needs and contexts. All of this lays the foundation for the learning material multiplier effect, where the materials can be used, processed and utilized in novel contexts and formats. Live courses can be revised without any downtime for the learners.

OpenWHO has done multiplication and diversification of the learning content dissemination to the extent possible with partners and country offices. The Pan-American Health Organization's Virtual Campus Platform (PAHO VC) collaborated from the onset of the pandemic by translating the English courses into Spanish and Portuguese and the two platforms, OpenWHO and PAHO VC, hosted them. The enrolments in the same courses hosted on both platforms added options for learners to choose their preferred channel. In March 2021, the platforms together hosted more than 4.5 million learners with PAHO VC adding a significant 605 856 learners.

There are other observed means of multiplying learning content use in Brazilian Health Institutes' portal and via countries' own channels. The multiplier effect expanded the reach of OpenWHO's learning response to health emergencies and provided targeted and localised learning, especially for remote and sparsely populated regions.

4.3 Concluding chapter summary

OpenWHO's descriptive data results from Ebola learning materials 2018 to 2019 and COVID-19 in 2020 to 2021 were analysed using thematical analysis. The processing informed two distinct areas of consideration for massive scale asynchronous online learning provision for organisations and interventions in which the equity and access are foundational values and targets. They are presented in two frameworks, one for aspects relating to online learning platform considerations, and another for online dissemination-based material packaging.

These results show that OpenWHO ensured learning was accessible in asynchronous formats to foster an expert-led approach to emergency learning. Information dissemination was empowered to different contexts and needs, and it was made possible to reproduce and adapt materials quickly and easily.

The European Health Literacy Consortium underlined that health literacy can happen when individuals access the knowledge, seek and find health information, comprehend it, appraise its meaning, interpret it, filter it and apply it for better health outcomes. All these aspects are within reach on OpenWHO. Most recently The Organization for Economic Co-operation and Development (OECD, 2021) recommended skills for adults related to the online learning: developing basic digital skills; motivating learners to complete the course and retain the information; issuing certificates of completion; and establishing quality assurance mechanism among other recommendations.

5 DISCUSSION

The research objectives were to examine elements of successful massive scale information dissemination through asynchronous formats and investigate the use of xMOOCs during epidemics and pandemics taking into consideration key enabling requirements for epidemic and pandemic learning. This research aimed to establish how online formats can enable large scale information dissemination and established key requirements for an asynchronous online learning platform and online learning materials packaging. The findings are based on outbreak and epidemic learning responses since 2017 and on just-in-time massive scale learning interventions during the COVID-19 pandemic years of 2020 and 2021 on OpenWHO.org.

The research findings converged into two distinct, thematic areas covering two aspects of online learning related information dissemination:

a) A framework for platform requirements to disseminate health information on a global scale.
b) A framework for requirements for the packaging of the online learning suited materials to upscale the use and dissemination for massive audiences.

The elements of the successful information dissemination of online learning are informed by the literature evidence and practitioners' practice presented in this research, the literature review and in the original publications. The results informing the platform requirements cover aspects regarding access and use cases globally – how different learner groups in different locations have accessed the platform, and how the platform offerings have serviced them. Further results derived from the materials relate to platform capabilities to enable learner completion and the tracking thereof, importance of platform data capacity and the ability to reproduce the situations where business continuity is interrupted or learning production content production operations are globally dispersed, like during the pandemic. Sourcing from the information dissemination models (see Chapter 2.3), some of the core elements include the factor of trust (Johnson & Meischke, 1993) and factors

influencing the use of information, such as the characteristics of channels best suited for dissemination and the utility which is informed by the personal background and relevance of the information presented by the information carriers (Basniat et al., 2018). The transfer, dissemination and diffusion aspects by Green et al. (2014) are informing similar processes as the mass scale online learning. They are thus a relevant source for this research, particularly relating to building the online format information dissemination based on key considerations. The model discusses data, format and tailoring as well as the analysis and interpretation of the information and data.

The Seeger et al. (2018) model is for evaluation, but it has elements of interest for frameworks informing mass digital content delivery. These include maintaining and increasing the source credibility as the central outcome, and looking into message consistency, tailoring, sufficiency and actionability. The information provision cycles (Greenhalgh, 2004; Ward, 2009; Graham, 2016) provided structure for the thematic analysis prioritisation of the intervention codes. In their model of "Making it happen" Greenhalgh et al. (2004) presented similar information to that of this research, where the scope is scientific, orderly, planned and programmed information dissemination, in which the knowledge cascade is the metaphor for spread.

The two frameworks are presented, synthesised, and discussed in the respective sub-chapter of this chapter. Both frameworks suggest key considerations followed by an explanation of what is targeted with these interventions, what value it is based on, delivery means and the measurement for success.

5.1 Platform requirements

This chapter presents the online learning platform requirements that relate to findings on globally reaching open access formats, bridging the digital divide, ability to produce content in a dispersed manner, recognising the learner for completion and continuous quality improvement of the learning, provided through depicting the data. The related framework, developed by the author, is shown in Table 5.

Table 5. Framework for key considerations for online learning platform requirements in global dissemination mode

KEY CONSIDERATION (theme)	TARGET (subtheme)	VALUE (subtheme)	MEANS (subtheme)	MEASUREMENT (subtheme)
Open access formats supported	Ensure widest possible access	Access	Free and open access delivery	Uptake and use globally measured
Digital divide bridged	Ensure unlimited reach taking connectivity into consideration	Equity	Low bandwidth adjusted and off-line use formats catered for	Evidence of use in low- and middle- income countries
Dispersed content creation enabled	Content production through dispersed and detached teams	Continuity	Contents can be produced independently by subject matter experts in events of disruption	Experts are empowered with simple solutions to produce content and revisions
Learner attendance and completion is recognised	Learners are committed to complete, and completion is acknowledged	Recognition	Course completion is followed by an automated certificate issuance	Completion rates and completion patterns
Platform uses data depicted to inform practice and design	Quality improvement through informed data	Impact	Big data on users and use is collected and analysed frequently	Use and user preferences monitored, surveyed and recorded

5.1.1 Open access formats

When planning a learning intervention which aims to be globally accessible and available for the widest possible audiences, the core value proposition is that of unlimited access. All possible barriers are to be crossed for the free and open access. The OpenWHO results show that learners need and join the public health information online as it becomes available from the health authorities such as the World Health Organization. The literature (OECD, 2020) refers to some fourfold increase in online learning searches in the early phase of the pandemic. On OpenWHO, the usage figures grew by more than eight- to tenfold and the highest

daily peak of learner enrolments on March, 30 2020 was 660 times higher than on the same day the year before. Results show that people around the world, young and old, began to look for answers from online learning to understand the novel coronavirus.

For an international level online learning provider, this magnitude of interest to enrol on online learning means a need to have solutions to host the upscale and at the same time, produce learning materials timely to meet the needs, and to sustain the increasing learning need.

The changes in the low-income country (LIC) representation in the OpenWHO calls for more studies to understand it, but as the research data overlaid the epidemiological case counts, one feasible explanation for lesser proportion of enrolments from LIC could be attributed at lesser burden of disease of COVID-19. Some learning results from the pandemic and epidemic learning provision experiences, including changes in the use patters before and during the pandemic, were captured earlier (Utunen, Ndiaye, Mattar et al., 2021) but there is a need to further establish means to institutionalize and strengthen emergency response through online means (Utunen, Gamhewage, Attias et al., 2020).

5.1.2 Digital divide bridged

The online platform learning intervention aimed to bridge any digital divide that could hamper learners from access. Platform offered low-bandwidth and offline formats from the launch of the platform based on the values of equity. To measure the success of this target, the learning provider would need to examine the enrolment data and user metrics from countries and locations with compromised internet connectivity, ensure the learning can be provided in smallest possible sizes and in formats that do not require online access, e.g., in offline formats.

OpenWHO platform formats are fully adjusted by reducing the learning content size to the absolute minimum. This way, the learning dissemination does not demand high network capacity for the content delivery. The OpenWHO platform shows use in low-bandwidth contexts and in least developed countries, and majority of the use before the pandemic was in the southern hemisphere epidemic contexts. At the same time, OpenWHO users did report internet connection issues, increasingly so in the Global South countries.

The World Bank (2020) provided recommendations for designers where interventions must be 'at scale' and available for low- and middle-income countries can access and adopt a mobile-first approach, setting up one-stop space for various learning resources and curating purposefully content for online formats rather than adjusting from other formats.

5.1.3 Dispersed content creation

One the core requirements for emergencies learning material production is the ability to fast-track the development of contents. It therefore comes of critical essence that the materials are both easy to produce and easy to access and use. The light and easy course formats are good for the learners in the low-bandwidth regions but also for the course producers who could produce content at their convenience and independently with low requirements on gear and technology. Several new courses have been released every month, with dozens of language versions and at the same time. The continuity has been ensured by allowing detached teams to produce learning materials. Previous research (Wang & Wang, 2009) indicates that quality and perceived ease of use increased the sentiment of usefulness amongst the instructors using online learning as a tool. Should any disruptions to the business continuity take place, such as the pandemic, the subject matter experts can continue the learning content production through online and remote modalities. The ability to self-produce easy and simply in the formats required is key to the continued operations to ensure the learning provision continues seamlessly amidst any abruptions such as the lockdowns.

5.1.4 Recognition of learner completion

MOOCs have held a significant promise in democratizing access to knowledge and learning, but also has caused disappointment since, for instance, completion rates can be lower than 5-10% in the commercial platform MOOCs (Rivard, 2013; Murray, 2019). Some industry studies (SH1FT company website) argue that e-learning can increase learning retention rates by between 25% and 60% as the learners can go back to the resources, take their own pace and repeat content as many times as needed. MOOC studies do not cover if these online courses are good

for all, or just for most persistent, self-directed learners as their initial findings show (Schultze, Leigh, Sparks and Spinello, 2017).

This growth is not limited to numbers of learners, as increased demand for learning during the pandemic has also led to increased learner commitment. OpenWHO usage statistics have shown that learners are now more likely to complete courses than prior to the pandemic, highlighting increased motivation across all learner groups. One of the core requirements for a provider of online learning is to ensure the learners' attendance and completion is recognized. As the aim is for learners to complete the learning, an acknowledgement of the completion is needed. In practical terms, the certificate is issued when a given threshold of learning is completed.

In the massive asynchronous learning modalities, this recognition of completion needs to be automated as the manual processing of quantities of certificates is not sustainable. The certificate awarding will contribute important information for the learning provider in terms of the data on completions and types of completion patterns the learners take. Just like concluded by the OECD (2021), the learning retention, measured by the completion and acknowledgement of it, must be built into a system of recognition that will encourage the learner forward.

This average course completion rate of about 50% on OpenWHO is much higher than the global MOOC average of 10-15%. Several studies (Rivard, 2013; Murray, 2019) have shown over the years that MOOC completion rates are far lower than the enrolment rates. Motivating online learners in one way or the other to complete is key to retention and continued learning. The self-paced formats therefore can be well suited, as the learner can determine when and how to complete the courses (Zheng, Bender & Lyon, 2021).

To engage learners, digital badges were introduced in 2021, providing easy to obtain, save and share recognition of the completion and this follows the value proposition suggested by Credly et al. (2013) on recognizing the adults' efforts on completing the learning.

5.1.5 Platform data informing practice

The aim in collecting and analysing the platform data is first and foremost to improve the quality of the learning provision. The platform data can at best inform on the

impact of the learning intervention. The sound and operational data elements allow for the continuous improvement of the platform operations by providing insight on the use and user preferences and can help the online learning platform provider to gain understanding from the data findings that relate to the learning material use.

Self-explanatory and simple data is a necessity for the learning provider to understand the material use, detect possible gaps and arrange for the general picture on how the learning platform works for the purpose for which it has been developed.

Well working snapshot data extracts can help particularly the massive scale asynchronous learning provider in depicting the learning reach, gaps and learner performance. The more automated the data is, especially as it gets into the big data scale, the more useful it is for the learning providers.

As OpenWHO experienced massive increases in the enrolments, it also put pressure on the data extraction, handling of data and simply analysing the core elements of the data. OpenWHO's learning response to the pandemic and epidemics has been improved by drawing and analysing its own platform data, where the metrics have affirmed that multi-use formats have enabled critical health information to reach those underserved online. Well-functioning data is among the best asset the online learning provider owns.

5.2 Learning material packaging aspects

The packaging of online, digitalised learning materials recommends real-time dissemination, learner-centric design, enabling language localization, serving the underserviced groups and provision of fully adjustable content formats. These below elements of online learning packaging do not necessarily need a dedicated platform and would apply to any dissemination through any channels. The related framework is visualized in Table 6.

Table 6. Framework for key considerations for online learning material packaging for mass audiences

KEY CONSIDERATION (theme)	TARGET (subtheme)	VALUE (subtheme)	MEANS (subtheme)	MEASUREMENT (subtheme)
Real-time dissemination prioritised	Pro-active and accurate information pushed out fast and frequent	Timeliness	Expedited launching of materials during events, predicting for future events	Release pace following an event and guidance publishing
Learner-centric design ensures independent learning	Pedagogical approaches for adult learners learning at their own pace	Independence, self-reliance	Self-explanatory formats support fully independent learning journey	Enrolment data and user metrics by user groups
Language localisation is made possible	Comprehension is improved	Adaptiveness, comprehension	Formats are favourable for oral productions and in different alphabets	Language and oral version produced and utilised
Underserviced groups are serviced	Expanding the reach by removing all barriers	Inclusion	Formats supporting the user experience	Formats for uptake and attendance by special needs groups
Content is developed in fully adjustable format	Re-production of learning materials into specific contexts	Ownership, Agency	Fully editable formats allow material use and adjustment, multiplication	Materials used outside the platform premise

5.2.1 Real-time dissemination

The real-time dissemination aims to pro-actively and accurately share relevant and up-to-date information that can help inform populations during an event. This intervention can be placed at local, national or international contexts. The information and learning provider can measure this by capturing the release of pace

of learning components in a specific event. Also, the actions to produce and stage learning materials for the future needs is part of the dissemination readiness.

Online learning and information dissemination on OpenWHO are impacted by the health emergencies and infectious disease outbreak response. However, the same prerequisites of having fast and frequent information dissemination would apply to any context of learning material sharing at scale in emergency settings.

5.2.2 Learner-centric, self-paced formats

Learner-centricity in the self-paced formats mean formats that are supporting fully independent learning journey. This gives the freedom of choice on formats, when, where and how to join the learning. Pedagogical approaches need to appreciate the fact the learner audience is diverse, and the self-explanatory materials need to be offered in order to provide clear and easily understandable materials. In areas of learning such as public health and novel pathogens, there is the need to decode the science into plain language and present the content in the format that reads at ease for the learners. The OpenWHO learners appreciated the easily accessible, free, informative, and simple formats and had listed these as the enabling factors.

At best the learning and information material provider can ensure the steps for the health information literacy to happen as effortless and easy as possible. Online learning is most applied through various digital forms being. Experience in Burkina Faso (Hebert et al., 2020) showed that the videos serve as an effective training tool for health professional and the key aspects of using videos to enable learning transfer. Similar evidence in other researches (Nugroho et al., 2019, Kendal, 2019) showed similar positive outcomes from the popularized infectious disease videos.

5.2.3 Language localization

Language can be a key determinant for improved health literacy (Translators Without Borders, 2015, 2019; Hunter-Adams & Rother, 2017; Perera et al., 2012). Language offering has also played critical importance in the OpenWHO surveys. Multilingual course production is one solution to bridge the barriers in learning. Additionally, the

production is arranged in plain language so that the materials are simplified for general audiences and in formats suitable for, for example, hearing- and vision-impaired learners.

OpenWHO has invested into the language localization as a high priority. To maximize impact, priority is on languages of Global South and of low- and middle-income countries. Attention is put on learners with special needs, as well as those languages that are most-spoken worldwide. The appropriate language offering can help the most disadvantaged and underserviced to access health information in disease outbreaks and other events.

The original publication III suggested a relationship between OpenWHO platform use in the countries with the highest number of COVID-19 cases during the study period in March-May 2020. It also provided evidence on use of national language use in the same countries at the same period showing important correlation among the three factors.

5.2.4 Materials for underserviced groups

Challenges, including gender inequity for access to education, reachability, infrastructure availability (i.e., internet, transportation, classroom space, etc.), and affordability usually hinder the learner from accessing trusted courses (Barteit et al. 2020). Results show that the pandemic brought more younger and older learners and women to OpenWHO platform, rendering public health education more equitable and expanding to reach previously underrepresented groups. OpenWHO helped in gender equity in access to education during the pandemic. The impact of gender is well documented among the important determinants in access to information amongst healthcare professionals, students and patients (Samurivo et al., 2019; Brown et al, 2020).

The different age groups attending to the platform diversified from before the pandemic time and the platform became more inclusive during the pandemic, reaching users above the age of 70+ and under 20 years. The older groups' attendance could be explained as the risk of severe illness from COVID-19 increase with age, and the younger population became interested in COVID-19 knowledge. Some literature has explored the elderly learners in the online contexts

(Liyanagunawardena & Williams 2016), but the increase to approximately 5% of all users on OpenWHO has been unique.

The OpenWHO enrolments geographically paralleled with the burden of disease in outbreaks and evidenced also during the early COVID-19, especially the low-income country attendance proportion decreased during the COVID-19.

5.2.5 Adjustable content

Online course materials on OpenWHO that offer alternative ways to access the content have catered to different learner needs. Feedback from surveys showed that the learners found the self-paced and flexibility of the courses to suit them. Adjustable formats have contributed to the local dissemination, adaptation and localisation and have brought the health information to more learners that would have otherwise been reached through the online platform. Complete adaptability for multi-channel hosting and sharing is imperative for materials to reach as broadly as possible. Adapting materials to local contexts is an ideal example of learning multiplication or diversification. It also includes adjusting the materials to the contexts in which they are best used, including into the languages. This can be done, for example, through making learning resources available as files in sizes that are small enough to download easily over a compromised internet connection. Further, using online learning materials in offline contexts leads to an extended multiplier effect where learning and information multipliers form the basis for sharing best practices on how learners can use materials in localized needs.

OpenWHO formats reflect the same suggestions as were made by the World Bank (2020) stating the low- and middle-income countries will benefit from the technology, where mobile comes first, and internationally produced content can be filled into national sites and clouds. This is allowed by flexible content packaging such as on OpenWHO.

5.3 Concluding chapter summary

The research findings converged into proposing two frameworks for key considerations for the health emergency related learning dissemination for mass audiences through online learning platform and online dissemination-based material packaging. The synthesis of the results provides that real-time learning in free access, low-bandwidth and offline use formats, including national and local language provision, choice of format for learners and adjustment of the learning contents based on adult learning principles works for global learning material dissemination.

Overall, when OpenWHO modalities are reviewed against the Greenhalgh et al. (2004) spread of innovation model, the work fits into the "make it happen" category where the defining features are scientific, orderly, planned and regulated systems. The metaphor of spread is that of information dissemination and cascading and in the later stages, re-engineering, that would be the multiplication and contextualising of the OpenWHO content.

The researcher argues that for the adults who are, as in Knowles' andragogy (1984), internally motivated and self-directed, goal and relevancy oriented and practical, the asynchronous online learning formats provide suitable tools to receive and learn from most current and accurate health information when shared equitably and in the formats suited for them.

xMOOCs might be labelled as authoritarian, but they do serve the purpose for instant, rapid, fast and frequent information dissemination. It is recognised that more targeted, interactive learning programmes with peer-learning and intense moderation work through cMOOCs and beyond will be required with more skills-building requiring learning. In-person demands small audience sizes that are manageable and are naturally considered as for other types of learning outcomes than digitalised learning journeys that at best address the immediate knowledge needs. While more personalised, skills building and behaviour change learning is required, moderated and interactive sessions and synchronous formats are needed, there is an equal need for the asynchronous modality. The massive scale learning response is in the right place to begin the self-paced asynchronous and instructivist delivery of health information, as the science readies and revises.

The OpenWHO pandemic learning response can serve as an example of applying the xMOOC approach to health emergencies information and learning

dissemination. In addition to reaching underserved populations, the OpenWHO case notably suggests that xMOOCs can motivate learners despite xMOOCs self-directed nature to produce high course completion rates. The findings support the position that asynchronous, one-directional information dissemination has a valid place in the online learning offering, especially in sudden-onset, global scale emergencies such as the COVID-19 pandemic.

5.4 Future research

The study contributes to the advancement of well-organised, predictable and managed information dissemination through learning in public health emergencies. Future research could involve testing the frameworks for asynchronous, self-paced learning interventions in other global contexts, such as in rolling out volunteers' information in emergencies, migration related questions or natural disaster related learning or similar domains. Being a rather new solution, OpenWHO did not have baseline information to assist with measuring and reporting on cost effectiveness or to contribute to the cost-benefit analysis. Along with exploring the effectiveness from a financial point of view, other related aspects such as effectiveness of the learning outcomes and longer-term impact assessment have not been employed in this study. Future interests would require examining how the self-paced asynchronous formats can systematically take stock on the learning outcomes and retention, also as a longer-term impact in the learners' knowledge attributes.

Additionally, future research could consider adapting content beyond basic translation to additional languages, including perceived credibility and effectiveness of online health information in health emergency contexts. The matter of comprehension continues to be of great interest from the point of view of cultural and contextualized understanding of learning materials and the influence of language formats, such as plain language. Similar work has been carried out in the context of health information by Translators without Borders (2015, 2019). Relatedly, it would be interesting to research additional opportunities for message tailoring (following on from previous research such as Enwald 2013) for effective health information dissemination with an emphasis on different phases of long-term crises, such as pandemics.

OpenWHO has been studied initially (Samo et al., 2022) from the point of view of establishing automatic evaluation for the linguistic complexity and this work initially has provided the groundwork for future research, as the automation in language provision has been identified as the way of the future.

Another interesting future benchmarking work would be in the area of certification. Unlike many degree-programme supporting platforms, OpenWHO has not been part of any certification system until the end of 2021 and the benefits of suitable certification systems in these contexts of voluntary, self-paced, continuous learning support programmes would be a needed study premise.

5.5 Limitations

This massive scale, self-paced learning delivery for the masses has not considered the studies on exactly how the disease-specific learning materials are utilised in different contexts by actors; and what the localised learning needs of the epidemic hit areas may be. Opting for mass delivery, the more detailed, contextualised learning needs assessments have not been performed and this has been an informed decision for OpenWHO.

The subject matter experts have delivered the critical required knowledge component in an expedited manner and determined the content based on the evidence-based science and guidance, that was then turned into learning format. For the future pursuits in this massive scale learning and health information dissemination intervention, it would be critical to be able to have means to verify how the learners who complete online learning can apply that knowledge in real-life situations.

Another limitation is that the long-term outcomes of self-paced online learning have not been accurately and comprehensively measured during the epidemics and the recent pandemic. Overall, the massive scale pandemic learning response has benefitted positively from the 10-year-old Massive Open Online Course innovation. At the same time, the MOOCs are merely a decade old and will continue to establish themselves in the world of learning.

6 CONCLUSIONS

Summary of the research

Five years of online learning and information dissemination on OpenWHO have contributed to the evidence of self-paced online learning and health information dissemination both in a platform context and for online learning material design. OpenWHO has disseminated critical information during the pandemic and epidemics with equity in access as a cornerstone value. The foundational principle was to ensure access in health events, outbreaks and the pandemic. Self-paced online learning has proven to work for large scale information dissemination.

The thesis consists of four articles covering aspects of health information dissemination through online means during health emergencies. Three provide evidence on COVID-19, and two provide evidence from other infectious disease online courses and learning materials. The commonality is the information dissemination through online learning means on OpenWHO during health emergency events. Study I captured the dissemination and use of the learning materials for Ebola virus disease outbreaks in 2017 to 2019. Study II evidenced global reach of an online COVID-19 course in multiple languages during the first pandemic months of 2020. Study III merged the platform use geographically and the incidence of COVID-19 during the first year of the pandemic. Study IV looked more broadly at online learning-based health information dissemination for mass audiences during the COVID-19 pandemic. Findings inform on the use of the online learning materials in the disease outbreaks and the user data confirmed a need for offerings in the languages spoken in outbreak-impacted areas. Online learning approaches were found to be inclusive and provided for equity, feasibility and accessibility for learners in health emergencies, reaching across different affiliations, geographic locations, age groups, adjusted to consider disabilities and limitations such as low-bandwidth connections.

The research aimed to gain an understanding of health emergency related online learning during the pandemic and epidemics. The key requirements for the online learning platform and learning material formats for mass audiences were investigated

through data acquisition of the descriptive statistical analyses published in the four original publications.

Working through the data I identified the codes that were significant and relevant for my research objectives and aims. I interpreted and combined codes from the original publications so that they formed themes and sub-themes in two distinct, separate domains, organised into two emerging frameworks in this study. I labelled all themes in the analysis and they were solidified into separate considerations under each framework, each having explanatory sub-themes. During the thematic analysis an investigation was undertaken to match the scoped models of information dissemination and the spreading of the health information by formal organisations against the themes arising from the research material. It became evident that none of the currently dominant information dissemination models (See chapter 2.3) were responding to the catalytic needs arising from the epidemic and pandemic learning response.

Informed by analysis of imperial data of OpenWHO, the research findings are presented in two frameworks for key considerations to be considered for massive scale asynchronous online learning and health information provision. The platform recommendations relating to online platform capabilities highlight the following: open access formats; bridging the digital divide; ability to produce content in a dispersed manner; recognising learner completion; and platform quality improvement through data analysis. The aspects relating to the packaging of online learning materials recommend real-time dissemination, learner-centric design, enabling language localisation, serving the underserviced groups and providing fully adjustable content formats and multi-channel sharing options.

While further research into information dissemination in health emergencies is needed, this research provides analyses of data collected during epidemics and the pandemic and links epidemiological trends and global uptake to form understanding of online learning use.

Overall contribution

The influence of the COVID-19 pandemic on online learning has been significant. OpenWHO data confirms that responders and the public needed to access health information at their convenience during the COVID-19 pandemic. In this context, the self-paced learning becomes essential. This study aimed to pinpoint specific online learning related platform and material packaging strategies that contribute to

maximised health information dissemination reach. This research shows the need to use instructivist and prescriptive learning formats, which the researcher argues have their significance and role in the online learning space of specific contexts, such as the pandemic.

The benefits of online learning, particularly during a pandemic when all other opportunities are limited, are indisputable. However, in some contexts online-learning approaches may be not feasible or may have limited reach due to barriers such as a low level of digital literacy and technical capacity, poor or no internet access, and other similar obstacles, that could be related to digital devices. In some contexts, there is a preference to learn in a group setting or use materials independently outside the platform premise. In these situations, it is key to have alternative means of digitalised materials for information dissemination that are shared through learning organizers, individuals or organisations. There is a need to transform digitalised learning materials into offline or alternative versions accessible to audiences who need them in a particular format.

The constant change relating to the health information and advice is a driver for audiences to join and re-join and refresh their knowledge on the advice, especially in the case of novel infectious diseases. The pandemic response required millions of people, especially frontline responders, to access lifesaving information to protect themselves and help others. Fast-tracking the development and delivery of learning and information dissemination materials during an emergency is necessary and issues of access are to be highlighted.

The pandemic learning response results showed that learning to protect one's own and others' health is important and required in emergencies. Access to up-to-date guidance can be done through asynchronous learning delivery. Based on these findings, the researcher argues that the xMOOCs, with their one-directional and instructor-led approaches, work for the purpose of mass dissemination as the critical first knowledge component. The xMOOCs are a suitable MOOC type to disseminate on a massive scale, such as in a public health emergency. The instructivist (Beaven et al., 2014; Onyesolu et al., 2013) and prescriptive (Williams et al., 2011) learning methods that are expert-driven suit the information dissemination for mass audiences in emergencies. Despite the critique on instructivist and prescriptive learning, they do fulfil a purpose when real-time emergency learning is required at scale and do so better than any other modality. This controlled and structured

content is key for sudden onset events, where reliable and expert-driven information needs to be disseminated afar, especially in the era of the infodemics.

The work adds to the empirical information for MOOC providers, on self-paced, asynchronous learning provision, the scope to which this work is limited. It adds to the body of evidence in health information dissemination in emergency learning contexts. It provides applicable and practical approaches to learning through online platforms in sudden-onset events, in which the one-directional learning transfer ensures the rigid and robust information flow from the experts and authorities to the public and larger audiences.

Significance

The research adds to the body of knowledge on how public health information dissemination in asynchronous online learning formats, both for platform requirements and the learning packaging, can best meet requirements in a public health emergency. The findings contribute to knowledge on how a real-time learning response in a health emergency can be best offered to global mass audiences through self-paced online learning. The research argues that asynchronous, one-directional information dissemination has a valid place in the online learning offering, especially in sudden-onset emergencies that touch the whole world, such as the COVID-19 pandemic.

A consistently pursued effort for equitable access is needed by policymakers, planners and organisations with public outreach function. The scientifically based health information dissemination needs to be established by organisations mandated to respond to any public health threat in a fast and scalable way.

The recommended approaches in adjusting materials for health information dissemination support the ownership and allow the validation of health information dissemination to health professionals and communities, which in turn will minimise misinformation and lead to better learning outcomes. Organisations offering emergency-related or other health information dissemination through learning could use the approaches in designing and delivering learning conducive to multiplication. The providers of similar learning and health information dissemination can draw from these findings and key considerations to respond to rapidly changing information needs.

The elements contributing to removing all barriers must be at the core of learning and health information dissemination intervention of this scale. Equity must be the

underlying principle and organising criteria for all the work in public health. Without equity in access to sources of trusted information, there cannot be adequate access to health and better health outcomes, also in public health emergencies where there is a critical need to protect individuals and populations.

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POSTERS

POSTER 1

Utunen, H., Ndiaye, N., Zhao, U., George, R., Attias, M. & Gamhewage, G. (2020). **Serving health emergency responders through online learning – findings from OpenWHO's global user metrics.** *Studies in Health Technology and Informatics*. Digital Personalized Health and Medicine, (270) 1387-1388. https://doi.org/10.3233/SHTI200455

POSTER 2

Utunen, H., Attias, M., George, R., Ndiaye, N., Piroux, C., Farzi, M., Sy, A. & Gamhewage, G. (2020). **Global Access to OpenWHO's Online Learning Resources for COVID-19.** *Studies in Health Technology and Informatics*. The Importance of Health Informatics in Public Health during a Pandemic, (272) 304 – 305. https://doi.org/10.3233/shti200555

POSTER 3

Utunen, H., Ndiaye, N., Mattar, L., Christen, P., Stucke, O., & Gamhewage. G. (2021). **Changes in Users Trends Before and During the COVID-19 Pandemic on WHO's Online Learning.** *Studies in Health Technology and Informatics*. Applying the FAIR Principles to Accelerate Health Research in Europe in the Post COVID-19 Era (287) 163-164. https://doi.org/10.3233/SHTI210838

POSTER 4

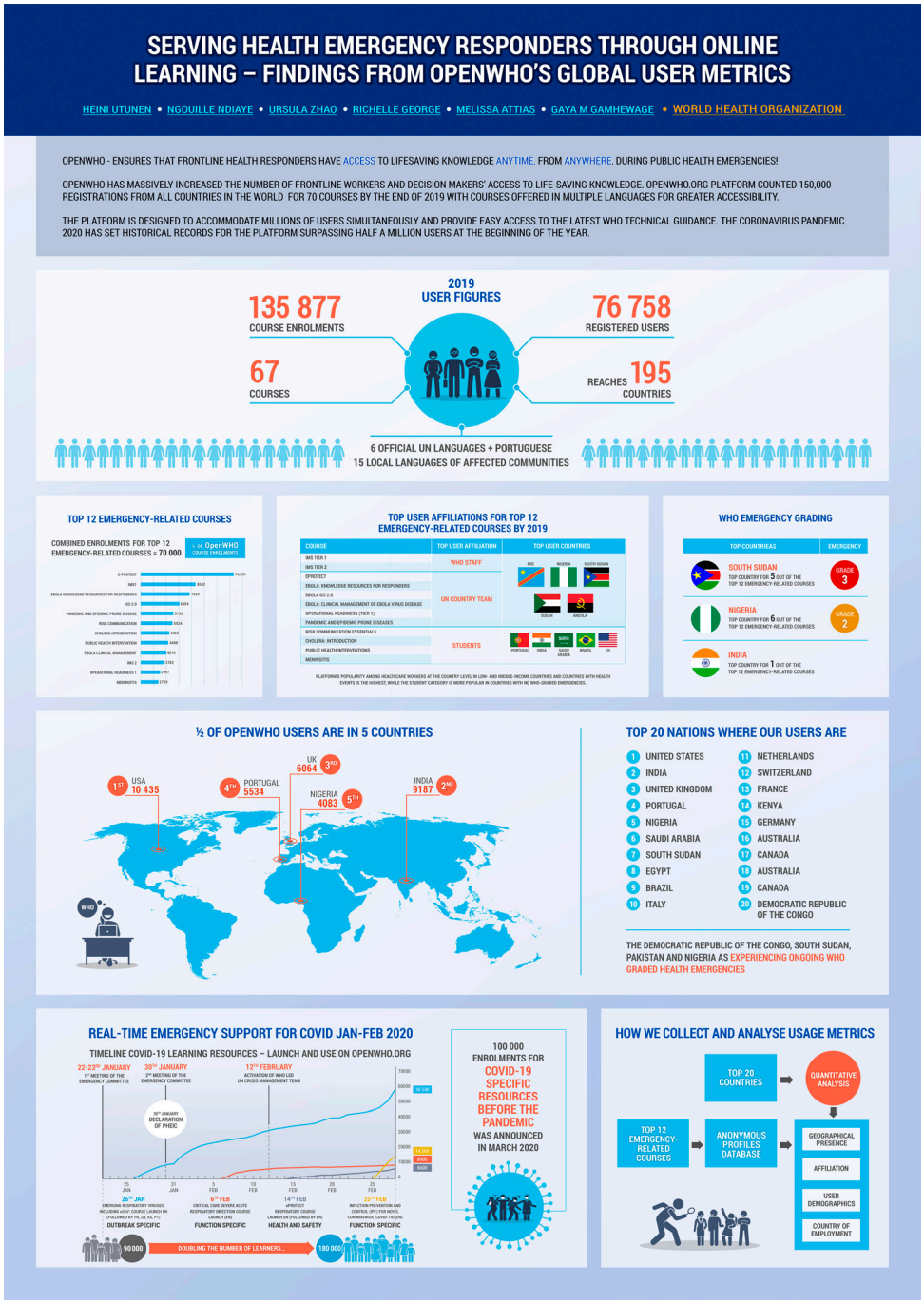
Utunen, H., Ndiaye, N., Attias, M., Mattar, L. & Tokar, A. (2022). **Multilingual approach to COVID-19 online learning response on OpenWHO.org: Ensuring equitable access to public health knowledge (2022).** *Proceedings of the ICIMTH Conference*, 16-17 October 2021, IOS Press, Amsterdam, The Netherlands, (289) 192 – 195. https://10.3233/SHTI210892

POSTER 5

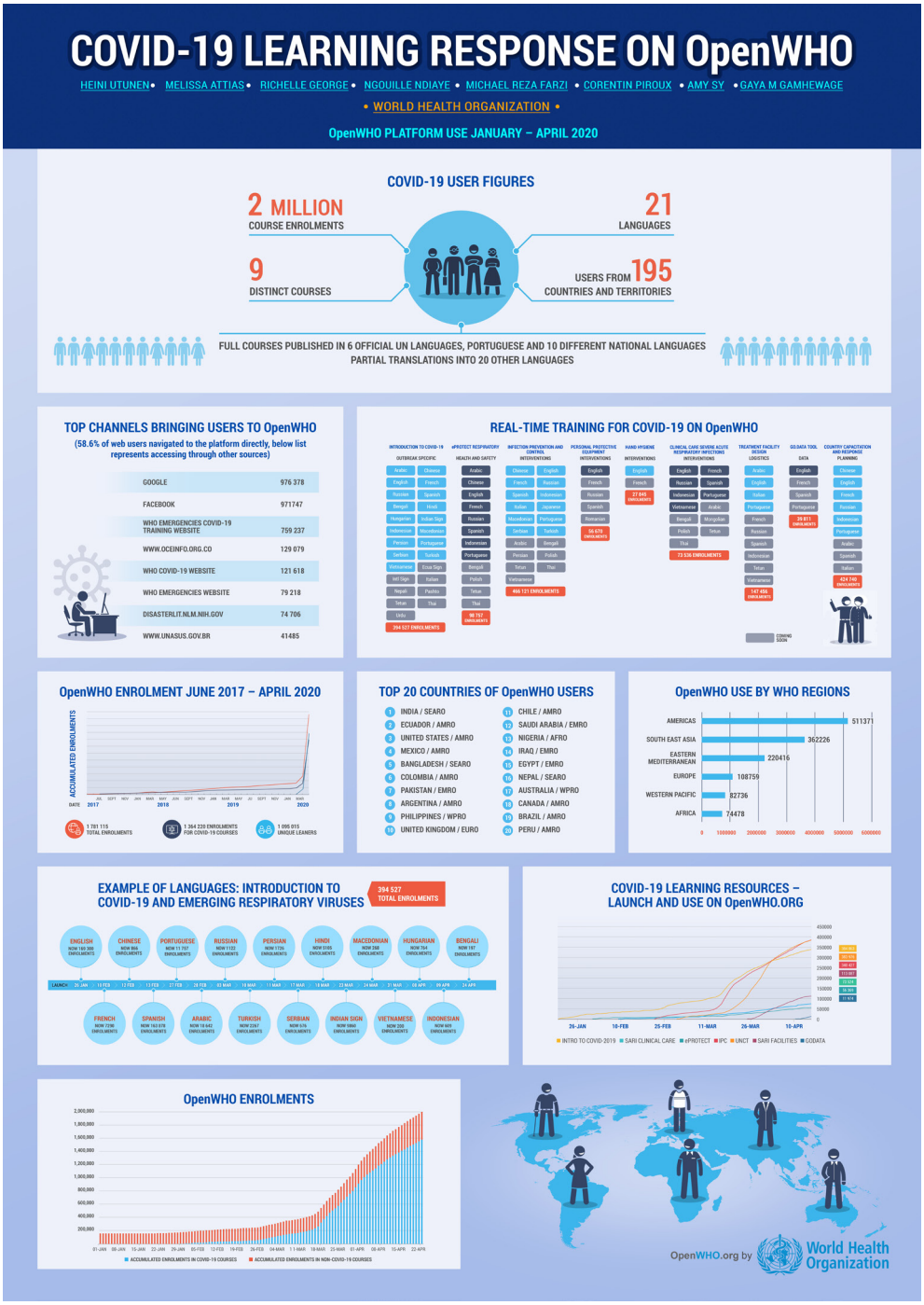
George, R., Utunen, H., Ndiaye, N., Tokar, A., Mattar, L., Piroux, C., Gamhewage, G. (2022). **Differences in OpenWHO courses used in low-, middle-, and high-income countries.** Figures from article Ensuring equity in access to online courses: Perspectives from the WHO health emergency learning response. (2022). *World Medical & Health Policy*. https://doi.org/10.1002/wmh3.492

ABSTRACT 1

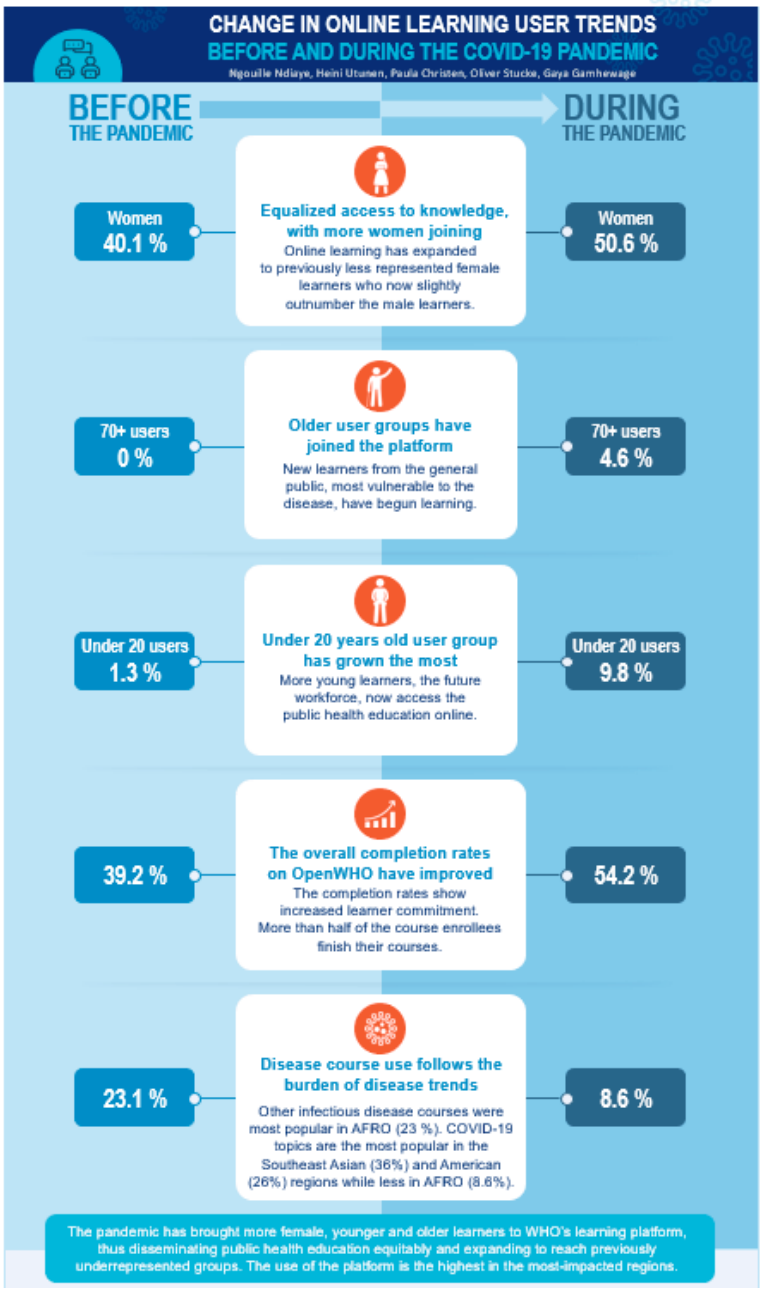
Utunen, H. (2022). **Transferring Real-time Knowledge Free of Charge Through WHO's Online Learning Platform OpenWHO.org.** *QScience Proceedings.* The Evolving Health Information Landscape Symposium 2021, Doha. Qatar, (1):5. https://doi.org/10.5339/qproc.2022.ehil2021.5



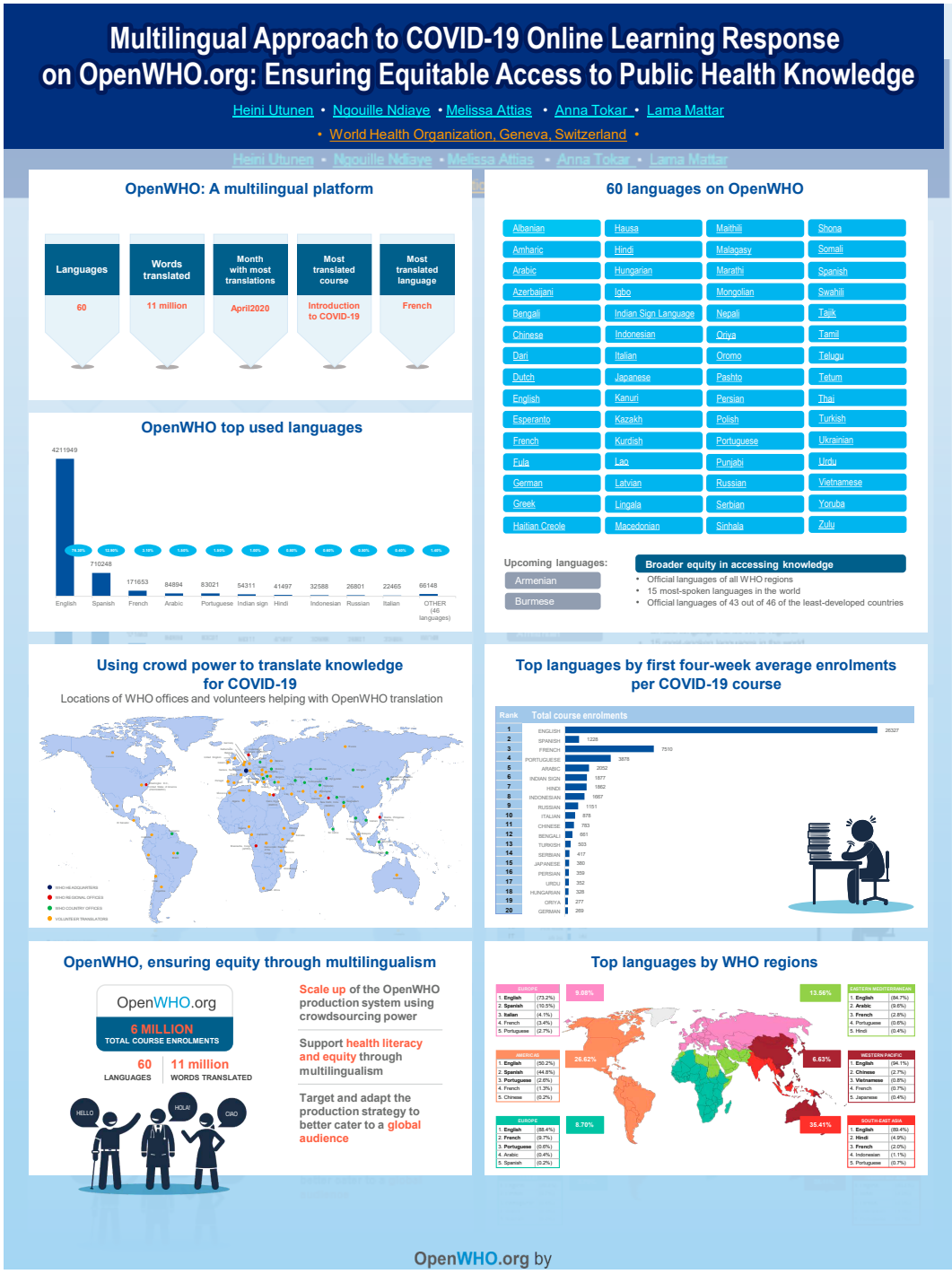
Poster 1. Serving Health Emergency Responders Through Online Learning (Utunen et al., 2020a)



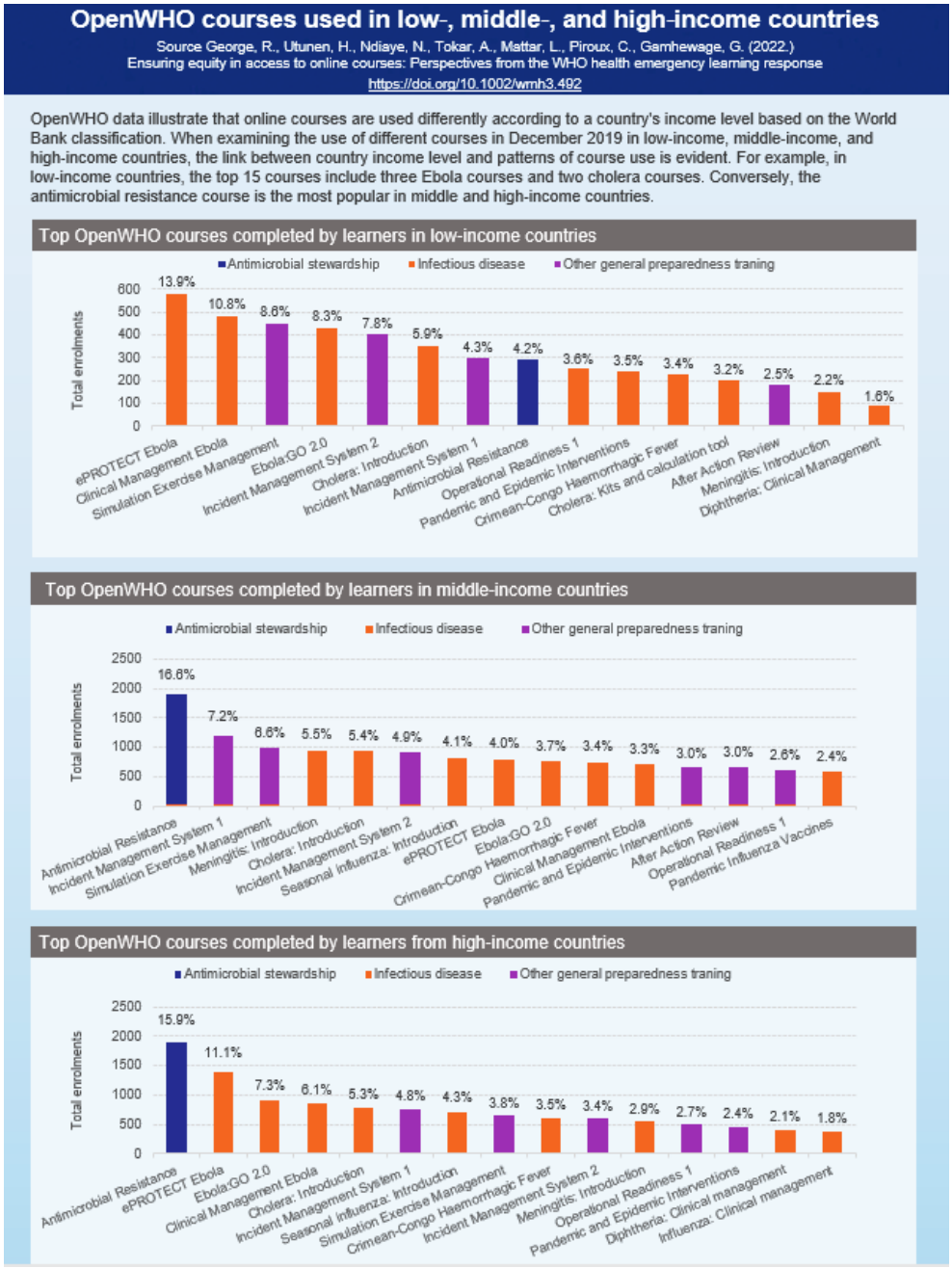
Poster 2. Global Access to OpenWHO's Online Learning Resources for COVID-19 (Utunen et al., 2020b)



Poster 3. Changes in Users Trends Before and During the COVID-19 Pandemic on WHO's Online Learning (Utunen et al., 2021)



Poster 4. Multilingual Approach to COVID-19 Online Learning Response on OpenWHO.org (Utunen et al., 2022)



Poster 5. OpenWHO Courses Used Different Countries Classified by World Bank Income Level (George et al., 2022)

QSCIENCE
PROCEEDINGS

The Evolving Health Information Landscape Symposium-
December 2, 2021-Virtual Doha

Transferring Real-time Knowledge Free of Charge Through WHO's Online Learning Platform OpenWHO.org

Heini Utunen*

Abstract

The OpenWHO.org was launched in 2017 to facilitate the transfer of the World Health Organization's public health knowledge for emergencies on a massive scale in anticipation of the next pandemic. Grounded in the principles of open access and equity, courses are free, self-paced, accessible in low-bandwidth and offline formats, and available in national and local languages. While the platform served front-line responders in outbreaks from Ebola to plague, Covid-19 marked its first pandemic test.

Demand for OpenWHO surged during the pandemic. In December 2021, OpenWHO hosted 6 million enrolments across 120 courses, including 39 courses for Covid-19 and 81 in other areas of WHO expertise, and had awarded 3.2 million certificates. Courses on 24 different diseases are introduced on OpenWHO. Courses were available in 60 languages, with more than 11 million words translated so that communities can access life-saving information in their mother tongues. The ability to massively scale up the transfer of life-saving knowledge in an emergency is based on ensuring access. It means removing all barriers, including that of digital access.

OpenWHO will continue to expand its reach and learning offerings, with a focus on systematically transferring the platform's services to serve countries with adapted and localized learning content, including national and local languages. The more equitable the knowledge sharing and dissemination from the trusted sources are, the more the learning resources are aligned with the specific needs of the vulnerable populations and the sooner knowledge shifts into behavior change, the better populations can protect themselves. In this, learning saves lives.

Keywords: Online learning, Covid-19; pandemic, WHO, OpenWHO, health emergencies

Abstract 1. Transferring Real-Time Knowledge Free of Charge Through WHO's Online Learning Platform OpenWHO.Org

PUBLICATIONS

PUBLICATION

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Digitizing Basic Occupational Health and Safety Knowledge for Ebola Virus Disease Missions – Reaching Frontline Responders Through an Online Course

Heini Utunen

In Cacace M. et al. (Eds.), *Well-Being in the Information Society. Fruits of Respect.* Communications in Computer and Information Science, vol 1270. pp 265-282

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Digitizing Basic Occupational Health and Safety Training for Ebola Virus Disease Missions – Reaching Frontline Responders Through an Online Course

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[2]Tampere University, Tampere, Finland

Abstract. World Health Organization's (WHO) ePROTECT course, an occupational health and safety online briefing for Ebola Virus Disease (Ebola) has become a key resource depended on by the responders battling Ebola at the frontline in all different professional roles in various organizations, mainly in the Democratic Republic of Congo (DRC) and its' neighbouring countries. It is a basis of the WHO′s duty of care and has been made mandatory for its own personnel before deploying into Ebola missions. Significant user figures beyond WHO staff suggest the online course is a critical resource transferring life-saving knowledge to responders at the Ebola frontline much beyond WHO. ePROTECT is hosted on an open-source online platform adjusted for low-band-widths, with mobile and download capabilities. The course enables knowledge transfer for the most complex settings and makes critical protective information available at ease, thus providing unlimited equity and access for any learner interested in it.

Keywords: Online learning; digitized learning; frontline response; health emergencies; Ebola Virus Disease; WHO; OpenWHO; information society

1 Introduction

Two latest Ebola outbreaks have taken place in the Democratic Republic of the Congo (DRC) in 2018. The first one was 9th in the DRC and centred in the Congo's Équateur province, was declared on the 8th of May 2018 and declared over on the 24th of July 2018 [1]. The following outbreak, 10th in the DRC, was declared just a week after the 1st of August 2018 by the Ministry of Health on the other side of the vast county, in the province of North Kivu, where the disease had never been witnessed before [2]. The latter North Kivu disease outbreak has continued until the beginning of 2020, making it the longest Ebola epidemic in the DRC in more than 40 years since the disease was first identified in 1976 close to the Ebola river in the northern DRC [3], as seen in Figure 1.

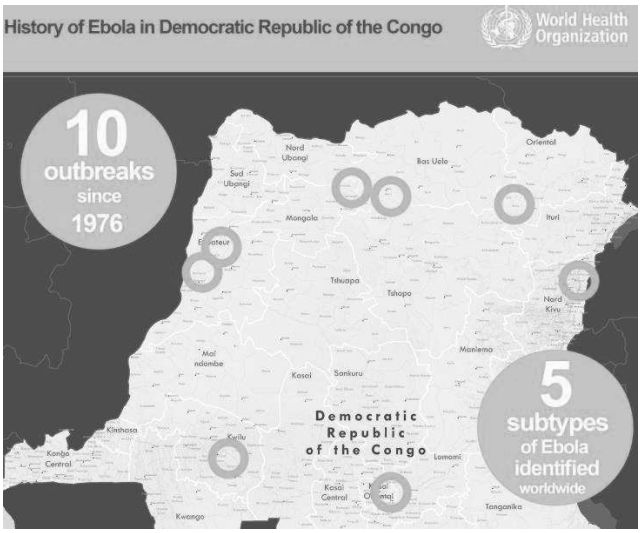

Figure 1: History of Ebola in Democratic Republic of the Congo [3].

Informed by the May outbreak 2018, a need for online learning resource for occupational health and safety for personnel deploying was identified jointly by the WHO Africa Region and the Learning Unit of the WHO Health Emergencies Programme (WHE). The course required that it be placed in an open-source, online, low-bandwidth adjusted learning environment. WHE had launched such a platform OpenWHO.org in 2017, to transfer WHO's technical knowledge to the frontlines in low resourced settings in any health emergency response such as the Ebola outbreaks. [4].

An online course, ePROTECT, a health and safety briefing in a Massive Open Online Course (MOOC) type of self-paced course format, was made available on OpenWHO on the 6th of June 2018 and was made a mandatory requirement for WHO deployments [5]. The learning resource was readily available as the 2018 North Kivu Ebola outbreak started in August 2018.

The course has witnessed a dramatic and sustained spike in the use along with other Ebola-related materials on the platform and significantly in the countries in Sub-Saharan Africa. The course is available in both French and English and provides basic information needed to prepare health emergency responders to stay safe and healthy for deployment to an Ebola-affected area. The course is generic and does not provide function-specific resources, for which there are other courses available on the OpenWHO. In total, five Ebola learning resources are hosted on OpenWHO as per Figure 2 below [6].

Figure 2: Ebola learning resources on OpenWHO.org

Some learning resources have been translated into local languages following a language mapping for the outbreak specific courses targeted for health care workers and clinicians. The outbreaks of 2018 required the translation into Lingala (spoken in Equator province) and Congolese Swahili, spoken in both Equator and North Kivu along with French and English. The ePROTECT was produced in English and French only due to initial target audience, the WHO deploying personnel to DRC, who speak either one or both of these languages.

The article further examines the elements of transferring knowledge and ensuring the reach for all those who need to access. Especially in the two Ebola outbreak hotspots in the DRC, physical access is restricted due to security-compromised, distant, and hard to reach areas. The online dissemination in suitable formats for the contexts is crucial to close the gap for equitable access to information.

1.1 Online Learning In Low Resourced Settings For Health Professionals

Currently, Massive Open Online Courses (MOOCs) globally present average completion rates of only 5-10% [7-12] and mostly remain the domain of high-income countries [7-8]. Veletsianos & Shepherdson (2016) highlight the MOOC learner spread over 194 countries with most users in North America and Europe and majority being male, 20-40 years old, and already possessing a college degree or higher [12-13]. Despite this general trend, the literature notes several programs that defy it.

One prominent success was an online course in nursing leadership in Americas, reported by Ortega and colleagues, with a 74-84% completion rate and a mean score of 90% on the final exam [14]. An online course in laboratory leadership and management in the Middle East and North Africa reported similar performance [15], as did a virtual campus in Mexico [16], and a cultural sensitivity training for rural Australia [17]. Online journal clubs [18] also proved successful. Murugesan and colleagues saw a completion rate of five times the average in a MOOC with majority low and middle-income country participation [7] and Laurillard reported a MOOC reaching 27 of the 47 most educationally-challenged countries and in particular the disadvantaged groups [19].

Learning is defined in Business English as "the process of getting an understanding of something by studying it or by experience" in Cambridge Dictionary 2019 [20]. Learning can be split into four different categories as introduced by Pedler and Aspinwall [21]:

1. Learning about things, i.e. knowledge acquisition,
2. Learning to do things, i.e. development of skills, competencies and abilities,
3. Learning to become oneself, i.e. personal development and,
4. Learning to achieve things together, i.e. collaborative seeking

Online learning in this article addresses the knowledge acquisition, learning about things. Other levels of learning cannot be easily conveyed through online learning, especially through OpenWHO self-spaced, non-interactive courses.

Health workers have different reasons to search for health information. Williams and his fellow workers (1992) classified those different reasons that still seem adequate [22]:

- Confirmation or rejection of the existing knowledge
- Assistance to solve a new or unusual health care issue
- Basic knowledge update on a specific subject through review
- Information research from another health field if the patient has multiple problems
- Dissemination of specific patient care concerns to fellow health care workers
- Identification of a rare or unfamiliar patient care issue
- Identification of a knowledge gap in the literature and a need for further research
- Assistance in the implementation of new administrative or institutional initiatives

Cordell et al. stated (1998) that as the healthcare field is heavily information-oriented, a well-managed "portable" information is crucial for every stakeholder involved, from frontline workers to policymakers [23]. Pakenham-Walsh and Bukachi (2009) established that information needs vary among health professionals, especially in developing countries [24]. Many factors influence the information needed continually. The factors can be related to their profession, their home institution, their culture and their usual infrastructure. Because of the complexity of those interrelated factors, there is no single method which allows a clear evaluation of health professionals' information needs. Every single health professional has specific information needs, which may vary over time, clinical caseload and place.

Pakenham-Walsh et al. (1997) stated that the healthcare system lacks relevant information in developing countries, which results in human losses and casualties that could have been avoided if the responders have had the right information at the right time [25]. Further, Eisenstadt et al. (1998) outlined that due to the mobility of health care professionals, functional changes should be taken into consideration to ease their practices [26]. The information should be pushed towards them, deliver extra support upon request from workers while making decisions. The information should have a clear and handy mobile interface while being able to support "fail-safe delivery" at an affordable cost and with low maintenance.

To break down structural barriers such as the lack of I.T. gear and training, the lack of time to access information on the ground, the lack of communication of information from higher levels, the management of the information is key as introduced by Rutland and Smith [27]. With a limited access to the internet in many rural facilities in developing countries (e.g. in Botswana), Park et al noted in 2016 that healthcare workers struggle to get right and timely information due to possible discrepancies or outdated information, which complicates their work and may result in a lower trust from patients [28].

Knowledge transfer is key for professionals in health emergencies as important practical information about an agency's emergency response procedures may only be known by an experienced administrator or someone who has been working for the organization for a long time. In such a situation, there is a need to update information among the health professionals working in emergencies. Gebbie and Merrill noted that public health organizations and individuals of the public health workforce themselves expect an adequate emergency preparedness to make sure the response is both relevant and timely [29].

2.0 Research Methods

Statistical data of the two identical courses, English and French, totalling more than 16,000 users was generated in September 2019, 15 months after the English course launch and 12 months after the French course launch. The data was collected from the online courses statistical data and metrics reporting system on the OpenWHO platform. User patterns and locations were analyzed based on Google Analytics, and OpenWHO platform's own statistics capabilities and data sets were overlaid. Parallel, a user survey was sent to all active course users through a platform course announcement. The survey received 706 (606 in English, 100 in French) responses on user motivation, learning needs and level of comprehension and were further analyzed to understand user personas and use case and generic user sentiments through their feedback.

3.0 Global Use Case Examined

The results show that English version of ePROTECT has 14,023 registered users, and 12,743 certificates of completion awarded with 90.8% completion rate. The French course has 2,307 registrations with 859-course certificates amounting to 37.2% completion rate. The English course completion rate of more than 90 % is beyond any industry standards [8, 10] and confirms the course is of a real need and completed diligently by the majority of the users. Also, the French course completion rate of 37 % is very high against general completion rates.

Table 1. ePROTECT Course overall use (English and French) as of September 2019.

Course	Launch date	Total enrolments	Certificates issued	Completion rate
ePROTECT (English)	5 June 2018	14 023	12 743	90.8%
ePROTECT (French)	6 June 2018	2 307	859	37.2%

Since the course launched early June 2018, as illustrated in Figure 3 below, both course enrolments and new user registrations swelled significantly in the months immediately following two outbreak declarations in the DRC in 2018. A very sharp spike was seen in October 2018, soon after two key events: firstly, in September 2018, WHO declared the risk of the spread of Ebola from the DRC to be "very high" at the regional level [2] and secondly, in October 2018, the U.N. and the Ministry of Health of South Sudan urged personnel to refresh their knowledge of Ebola and recommended the course. South Sudan's 1000 enrolments made the country reach the third highest gross number of all enrolled users on the course at the end of 2018.

The increases in course enrolments and user registrations that had been sustained throughout 2018 also continued into 2019 and increased again as the Director-General of WHO declared the North Kivu outbreak to be a Public Health Emergency of International Concern on the 17th of July 2019 [2].

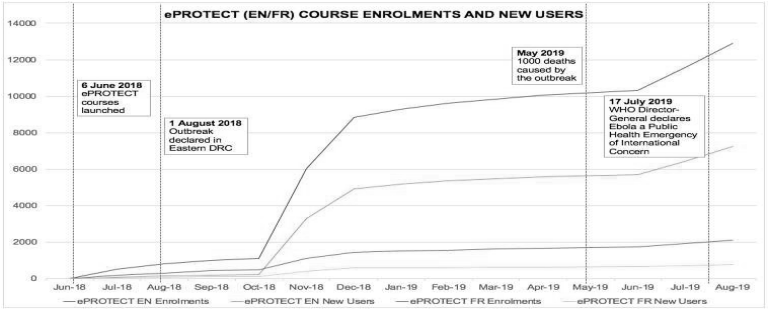

Figure 3. ePROTECT course enrolments June 2018-August 2019 with key outbreak milestones. The new users graphs show the proportion of new learners brought by the course to the OpenWHO platform.

As in Introduction, ePROTECT is one of the five Ebola resources on the OpenWHO.org. Also, other Ebola courses witnessed an increase in interest as the first DRC outbreak was declared in May 2018 (Figure 4). All Ebola courses attracted hundreds of users and reached to thousands of users as the second outbreak surged from August 2018 onward. ePROTECT is most popular Ebola-related course by registrations and was the second most popular course on OpenWHO after the Antimicrobial Resistance (AMR) course in 2019. Only when the novel coronavirus disease 2019 (COVID-19) started, the COVID-19 resources have become more popular than ePROTECT Ebola and AMR.

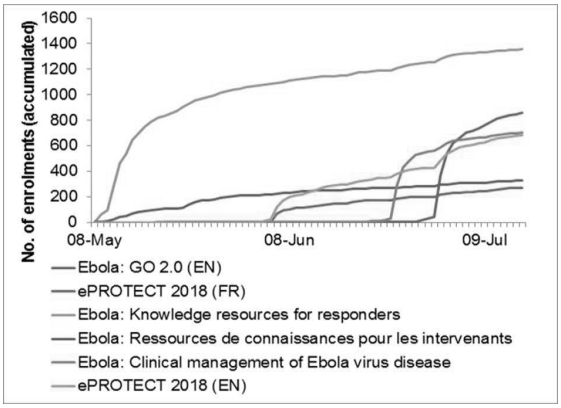

Figure 4: Use of OpenWHO knowledge resources during first Ebola outbreak of 2018.

When examining the global use figures of the ePROTECT course, the northern hemisphere is at the lead in the top ten English language course use (Table 2a). The top ten for the French language (Table 2b) course is similar, with half of the countries' registered users being the same in both languages. In this, the user pattern is very similar as in the MOOCs overall globally [7-8]. Positively, the African countries close to and in the countries of Ebola outbreaks, constitute a significant use case for ePROTECT. The use is very centralized in total, the top five user countries constituting 41% of all ePROTECT users across the two-course languages.

Table 2: Top 10 countries by registrations, English course (2a) and French course (2b).

2a English course	Learners	2b French course	Learners
United States	5096 (34.91 %)	United States	374 (15.45 %)
United Kingdom	3490 (23.91 %)	United Kingdom	343 (14.17 %)
South Sudan	1654 (11.33 %)	DRC	315 (13.02 %)
Netherlands	*761 (5.21 %)*	South Sudan	131 (5.41 %)
Italy	*447 (3.06 %)*	France	87 (3.60 %)
Denmark	*341 (2.34 %)*	Netherlands	77 (3.18 %
India	*320 (2.19 %)*	Ruanda	59 (2.44 %)
Nigeria	*303 (2.08 %)*	Guinea	43 (1.78 %)
Kenya	*252 (1.73 %)*	Cameroon	38 (1.57 %)
France	*251 (1.72 %)*	Switzerland	38 (1.57 %)

By September 2019, the countries with most users in the southern hemisphere are South Sudan, India, Nigeria and DRC, as in Table 2. To halt the spread of Ebola, 2 out of these, South Sudan and DRC are listed as Priority 1 countries for Ebola operational readiness by the WHO (Figure 5). South Sudan alone attracts almost 2,000 users to the course.

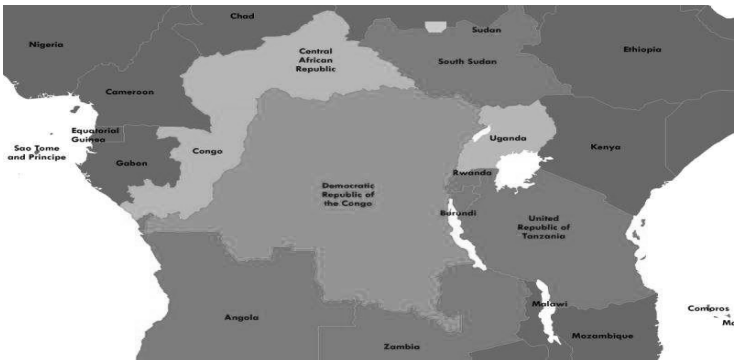

Figure 5: WHO Regional Strategic Ebola Virus Disease Readiness Preparedness Plan June 2018 – February 2019, WHO AFRO [30].

One reason for the proportionally rather high northern hemisphere attendance could be that the course was requested to be completed by the international deployees to the Ebola response and therefore parts of the users are naturally from outside the Congo and neighbouring countries. This also explains the fairly low user number in the DRC itself; the local responders are not requested to complete the course. Knowing some of the Congolese Ebola responders personally, they also have experience from previous Ebola outbreaks in the country.

The user survey shows the motivation for the users (Figure 6). They are divided by compulsory and personal protection related motivations and those with interest in the disease itself and strengthening their own knowledge. The English course users were by those to whom it had been made compulsory or who wanted to gain more knowledge and protect themselves. The biggest motivation for the French course users was the strengthening of the CV or qualification for future assignments, which was the smallest number of responses to motivation question by the English course users. This depicts that the French course was likely performed by personnel to whom it was not mandatory, but an investment in learning and career. These could be personnel from the DRC or other countries in the vicinity. The lower course completion rate of the French course could be explained by this factor too.

Several users also stated that having completed the course they have decided not to seek to deploy to Ebola missions. In this, the course can function as early information and "reality check" to whether staff is willing to take risks related to the virus being one of the deadliest infectious diseases but also related to the environments in which the response is operating, including severe physical risks such as other infectious diseases, armed conflict and violence, active volcanoes and methane filled lake in North Kivu and the surrounding areas. User testimonials also stated that the course had boosted their confidence before deployment, provided adequate information to protect them and helped their families understand the dangers they could face.

Figure 6: ePROTECT survey respondents on "What was your motivation for taking this course?" n=706 (EN 606, FR 100)

Similarly, when asked how the survey respondents heard about the course (Figure 7), more than half of the English course users indicated their employer and approximately one third had found it on the internet themselves. One in ten had heard from a colleague or friend. In the French course, half of the respondents had found it themselves from the internet, and one in four through colleague and even less through the employer. The French course user profile, therefore, aligns with their different motivation too, that of self-interest and self-searched user.

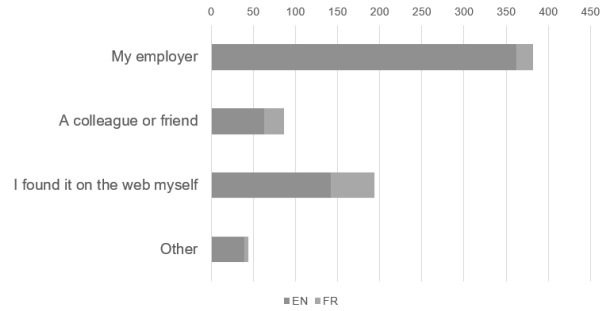

Figure 7: ePROTECT survey respondents on "Where did you hear about this course?" n=706 (EN 606, FR 100)

The most common professional affiliation of users enrolled in the course across all users is "UN country team (UNCT)", which makes up almost half (46%) of all the course's registered users and confirms the course's popularity at the country-level (Figure 8). The second and third most popular professional affiliations of users are "international organization" and "NGO" respectively. Of the WHO staff, a total of 677 had enrolled into the course. WHO has deployed approximately that amount of international staff during the first year of response and it corresponds to the figures being a compulsory requirement. Similarly, "UN country team" is the most popular professional affiliation

of users based in South Sudan, Sudan and Kenya as detailed later in the article.

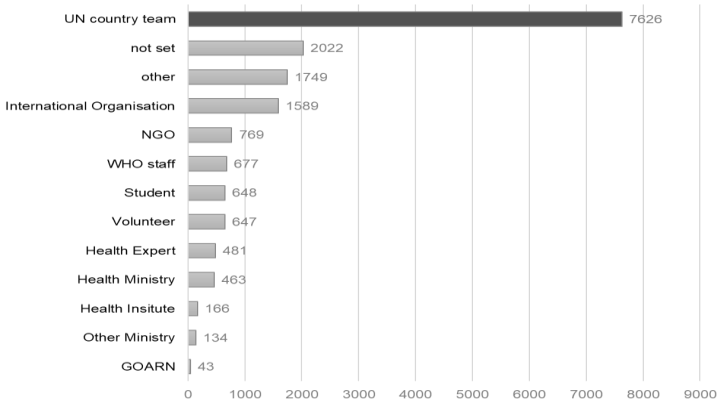

Figure 8: ePROTECT English and French course users' professional affiliation. *Not set means the course participant has not wanted to reveal the professional background. *Other means their affiliation is not in the 12 affiliation options offered.

When examining the age and gender distribution across the courses (Figure 9), the biggest user group for both languages is aged 30-39 years, with younger and older cohorts been less represented. The 50-59 are already a significantly smaller group and 60-69 very small user groups. Of those users who marked their gender, the clear majority are men, in the French course the male proportion being even higher than in the English course. This speaks to Veletsianos and Shepherdson's findings [12] on the MOOC learners in the northern hemisphere, the majority being male 20-40 years of age. What we do not know of OpenWHO users is whether they already possess a college degree or higher. Typically, OpenWHO provides topic and outbreak-related additional training for already professionals in their domains. This is the case of the WHO and U.N. deployees to health emergencies; they are mandatorily experts of their own domains already.

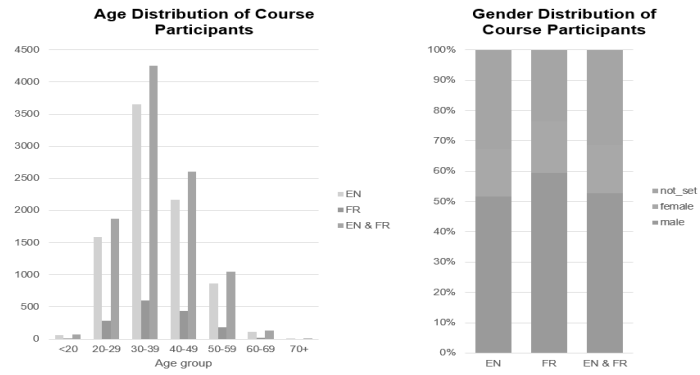

Figure 9: Age and gender distribution of the participants who disclosed the information.

Lastly, on the global use, the channels of bringing users to both English and French courses are somewhat different. English course is found mainly through Google, WHO Ebola websites and thirdly by UN National Library of Medicine, the latter being the main site for the French course users to find the course. Social media such as Facebook is much less important for both language courses but still brings traffic to the platform. A larger survey of the whole of OpenWHO platform traffic analysis showed similar differences between English and French site users [31].

A deep dive into users in Ebola readiness and preparedness countries of the WHO African region (Figure). The nine countries are surrounding DRC, namely Rwanda, Burundi, Uganda, South Sudan, Tanzania, Central African Republic, Republic of the Congo, Zambia, and Angola. All Ebola-related courses on OpenWHO platform in general, but the ePROTECT, in particular, has witnessed a spike in enrolments from the DRC and neighbouring countries, where 2 in 3 of all course participants are based at. According to the user survey, 2 in 3 users of the English course and 1 in 3 users of the French course have worked in Ebola response. Between the 9th of October and the 25th of October 2018, the platform successfully welcomed 500-600 new users per day from the priority countries for Ebola preparedness activities, with a record of nearly 1000 enrolments from South Sudan, after a successful UNCT campaign to recommend the course to the personnel.

These countries contributed approximately 900 new course enrolments a day across the English and French versions of the ePROTECT course at the end of the year 2019, during the heavy transmission of the second DRC Outbreak. Sudan belongs to the WHO Eastern Mediterranean region and is therefore not in the African Regional Readiness and Preparedness Plan but counts as a significant use case.

Looking at the largest use in the southern hemisphere by countries (Figure 10) there is a variety in the personnel registered, with South Sudan and Kenya UN country team being the biggest groups. In the countries with no Ebola outbreaks, such as India and Nigeria, the students and volunteers are the leading user groups by numbers. The same pattern is seen throughout the OpenWHO course use.

	South Sudan	**India**	**Nigeria**	**DRC**
Number of users	3224	342	241	300
Top user affiliation	UN country team (1976)	Student (206)	Volunteer (47)	UN country team (49)
2nd most common user affiliation	International organizations (326)	Other (29)	Health Ministries (44)	International organizations (46)
3rd most common user affiliation	Other (315)	Health Expert (24)	Other (35)	NGO (41)

Figure 10. Top 4 countries in the southern hemisphere and top user affiliations.

Finally, the user feedback in the open comments of the user survey was extracted by most popular words and analyzed using BigML and clustered by the lead word and most frequent words to review what type of topics are repeated in the answers. The open-end comments provided word clusters as in Figure 11. Astonishing 97,8 % of the respondents would recommend the course to others.

Figure 11: User survey's most popular words from the open comments analyzed using BigML and clustered by the lead word and most frequent words.

4.0 Discussion

The ePROTECT as a use case shows evidence on how protection measures for staff health and well-being in a dispersed organization can be conveyed through online knowledge transfer and how the barriers to access can be removed digitally. Further, the user research shows that the course has become a critical resource transferring life-saving knowledge to any responder beyond WHO deploying or planning to deploy to the Ebola frontline.

The global use case of the ePROTECT is very diverse due to the Ebola community globally, either in the countries with Ebola outbreaks or personnel working or interested in working in the response. The users largely represent the same phenomena as the MOOCs globally, by age, gender and geo-location. The reverse trend is higher than global average MOOC use in the southern hemisphere, with the topic and online packaging in a format suited for the purpose, thus abolish the barriers in accessing information in the frontline of the response. The other significant difference to global MOOC trends is the very high completion rates.

The reach and accessibility for the ePROTECT is granted, as it is hosted on an open-source online platform adjusted for low-band-widths. Importantly, there is an aspect of reach and access and use case of this online learning in the low resourced settings, often less represented in the domains of massive open online courses as referenced by the literature. Interestingly, the discussion spaces on the course seem to create a micro-cosmos, an area where information society without the borders, online, is enabled among peers.

While the course was initially targeted to WHO personnel, it has started living its' own life as a recommended resource by other UN and employers. The high number of UNCT and international organization registrations suggests that the course is a WHO service of a specialized agency in health to the rest of the UN. The references made by UNCTs such as in South Sudan and the U.S. National Library for Medicine are important channels in bringing learners to the course. Therefore, getting the course recommended by trusted organizations can make it even more popular. The user feedback gives a positive testimony of the course suitability in familiarizing and preparing for Ebola response mission.

4.1 Limitations and Suggestions for Further Future Research

The research examined the users, their motivation and use case of the ePROTECT. The data available gave adequate information for the purpose. Course statistical data has some limitations as the user might have registered in another country and uses the course in another. Also, if a foreign VPN is used for internet routing, the real use location is not captured. Given the data set includes more than 16 000 users, the general use case is still clear.

The user survey has its limitations, as only about 4 % of the users responded to it, but proportionally the same share responded of the English users (4,32 %) and French users (4,31 %). The Ebola responders and the UN staff in the emergency domain might be along with the busiest people in the world, fighting the diseases in complex contexts. Therefore, the response rate is satisfactory. Repeated user surveys for instance upon the repatriation from a mission could be considered as well as in-depth user interviews would bring more clarity on the course's usefulness.

WHO personnel in countries also calculate as the UN country team, but as only one affiliation could be chosen, most likely all WHO personnel have chosen WHO, though they could be UNCT members too. Further research would be necessary to understand user backgrounds, their employments going forward and after deployment review of the usefulness of the material.

Given the languages in potential Ebola contexts and the readiness countries, Arabic and Portuguese course necessity could be assessed. Some service design research would benefit the different language courses, given more than 25 % French users said that navigation in the learning content was not easy. Only 2 % of the English users felt the same.

For the future, comparing, during the time of the article submission, WHO has made available ePROTECT for severe respiratory infections for the COVID-19 emergence. Need for ePROTECTs for other transmission modes and vectors could be examined among the responders.

Additional research could include information acquisition in online learning platforms related research and further research to understand the users' information behaviours, including how the real time information dissemination between responders in the collaborative and discussion groups could be utilized better. Online information literacy research could also inform the differences in between the various language users and help target resources to different audiences.

5. Conclusion

The course acts as a primary introduction to Ebola deployment and is a core resource used by thousands of current and future frontline Ebola responders thus fulfilling the duty of care for WHO and similar organizations which are deploying personnel into one of the deadliest diseases known. The course users are from all around the world with a fair balance between south and north. The course would form a readily available knowledge base if the Ebola outbreak were to flare up in other countries.

The information related study fields benefit from the research as it provides user findings from a global platform. This research could also set a precedent for other organizations operating in the similar environments and mandated in the information dissemination and capacity building.

The research provides evidence on the power of online learning in emergencies and how it can benefit organizations deploying and planning to deploy personnel to demanding missions. The real time production of resources for personnel in easily accessible formats is the 20th century solution for geographically dispersed organizations to bring learners into the same source of trusted information.

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PUBLICATION II

Global Reach of an Online COVID-19 Course in Multiple Languages on OpenWHO in the First Quarter of 2020: Analysis of Platform Use Data

Heini Utunen, Ngouille Ndiaye, Corentin Piroux, Richelle George, Melissa Attias & Gaya Gamhewage

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Original Paper

Global Reach of an Online COVID-19 Course in Multiple Languages on OpenWHO in the First Quarter of 2020: Analysis of Platform Use Data

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Abstract

Background: At the onset of the coronavirus outbreak, the World Health Organization's (WHO) Health Emergencies Learning and Capacity Development Unit, together with the WHO's health technical lead on coronaviruses, developed a massive open online course within 3 weeks as part of the global response to the emergency. The introductory coronavirus disease (COVID-19) course was launched on January 26, 2020, on the health emergencies learning platform OpenWHO.org.

Objective: The aim of this paper is to investigate the geographic reach of different language courses accessed by a worldwide audience seeking information on COVID-19. Users' professional identities and backgrounds were explored to inform course owners on the use case. The course was developed and delivered via the open-access learning platform OpenWHO.org. The self-paced resources are available in a total of 13 languages and were produced between January 26 and March 25, 2020.

Methods: Data were collected from the online courses' statistical data and metrics reporting system on the OpenWHO platform. User patterns and locations were analyzed based on Google Analytics and the platform's own statistics capabilities, and data sets were overlaid. This analysis was conducted based on user location, with the data disaggregated according to the six WHO regions, the top 10 countries, and the proportion of use for each language version. Data included affiliation, gender, age, and other parameters for 32.43% (52,214/161,007) of the users who indicated their background.

Results: As of March 25, 2020, the introductory COVID-19 course totaled 232,890 enrollments across all languages. The Spanish language course was comprised of more than half (n=118,754, 50.99%) of all course enrollments, and the English language course was comprised of 38.21% (n=88,988) of enrollments. The WHO's Region of the Americas accounted for most of the course enrollments, with more than 72.47% (138,503/191,130) enrollment across all languages. Other regions were more evenly distributed with less than 10% enrollment for each. A total of 32.43% (52,214/161,007) of users specified a professional affiliation by choosing from the 12 most common backgrounds in the OpenWHO user profiles. Before the COVID-19 pandemic, users were spread over the 11 distinct affiliations, with a small fraction of users identifying themselves as "Other." With the COVID-19 introductory course, the largest number of users selected "Other" (16,527/52,214, 31.65%), suggesting a large number of users who were not health professionals or academics. The top 10 countries with the most users across all languages were Argentina, Chile, Colombia, Ecuador, India, Mexico, Peru, Spain, the United Kingdom, and the United States.

Conclusions: The online course has addressed a worldwide learning need by providing WHO's technical guidance packaged in simple formats for access and use. The learning material development was expedited to meet the onset of the epidemic. Initial data suggest that the various language versions of the course, in particular Spanish, have reached new user groups, fulfilling the platform's aim of providing learning everywhere to anyone that is interested. User surveys will be carried out to measure the real impact.

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(J Med Internet Res 2020;22(4):e19076) doi: 10.2196/19076

KEYWORDS

online learning; OpenWHO; novel coronavirus; COVID-19; coronavirus; pandemic; WHO; e-learning; MOOC; public health

Introduction

Background

The focus of this study is the World Health Organization's (WHO) health emergencies platform OpenWHO.org, which hosts online learning resources for outbreaks and epidemics. OpenWHO is an open source online platform adjusted for low bandwidths with mobile and download capabilities. This free, web-based knowledge transfer platform was designed for massive, real time use during a pandemic and has been in a real test during the early part of 2020 in offering free online courses to improve the response and preparedness for coronavirus disease (COVID-19).

The COVID-19 resources are hosted on two learning channels on the platform: one for courses in official UN languages and a second for courses in additional national languages. The first course related to COVID-19, "Introduction to emerging respiratory viruses, including COVID-19: methods for detection, prevention, response and control," was launched on OpenWHO on January 26, 2020, following the first WHO Emergency Committee meeting on January 22 and 23, 2020.

The course has four modules:

1. Introduction to emerging respiratory viruses, including COVID-19
2. Detecting emerging respiratory viruses, including COVID-19: surveillance and laboratory investigation
3. Risk communication and community engagement
4. Preventing and responding to an emerging respiratory virus, including COVID-19

This first edition of the course includes introductory information on the novel coronavirus and other coronaviruses, and basic information for anyone wanting to understand the new epidemic. By the end of the course, learners should be able to describe the nature of emerging respiratory viruses, how to detect and assess an outbreak, and strategies for preventing and controlling outbreaks due to novel respiratory viruses, as well as what strategies should be used to communicate risk and engage communities. The course was packaged and presented through PowerPoint slide decks, and video recordings by WHO health experts in different areas of work were added during the following days and weeks. This simple packaging allows for material to be used on multiple devices, in low-bandwidth settings, and through an offline function in the mobile app. The packaging of the online courses with videos and slide decks also supports the ability to update the material to reflect the frequently changing and updated WHO technical guidance.

Due to the changing content during the first months of the Public Health Emergency of International Concern and the first weeks of the pandemic, the OpenWHO team did not make available any quizzes as is usual for other courses on the platform and, thus, was not providing a certificate of completion. These features will be added once the technical content can be considered more final and established.

The timeline in Figure 1 shows the launch of the course in different languages and the total enrollments as of March 27, 2020, the day the OpenWHO platform reached 1 million enrollments.

The course was published on January 26, 2020, in English and was gradually published in all other UN languages. Another 7 national languages were produced by the courtesy of dozens of volunteers providing spontaneous translation offers from WHO country and regional offices and headquarters, as well as volunteers from public health institutes and educational units. All volunteers were seeking to provide support to maximize the local-level uptake of courses for an effective response to the pandemic. Among other efforts, OpenWHO released an introductory video to COVID-19 in Indian sign language, the first sign language resource on the platform.

This study looks at the course use in all of the WHO regions. The WHO Member States are grouped into six WHO regions: African Region, Region of the Americas, Eastern Mediterranean Region, European Region, South-East Asia Region, and Western Pacific Region, as shown in Figure 2.

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Figure 1. Introduction to coronavirus disease course languages and enrollment figures as of March 27, 2020.

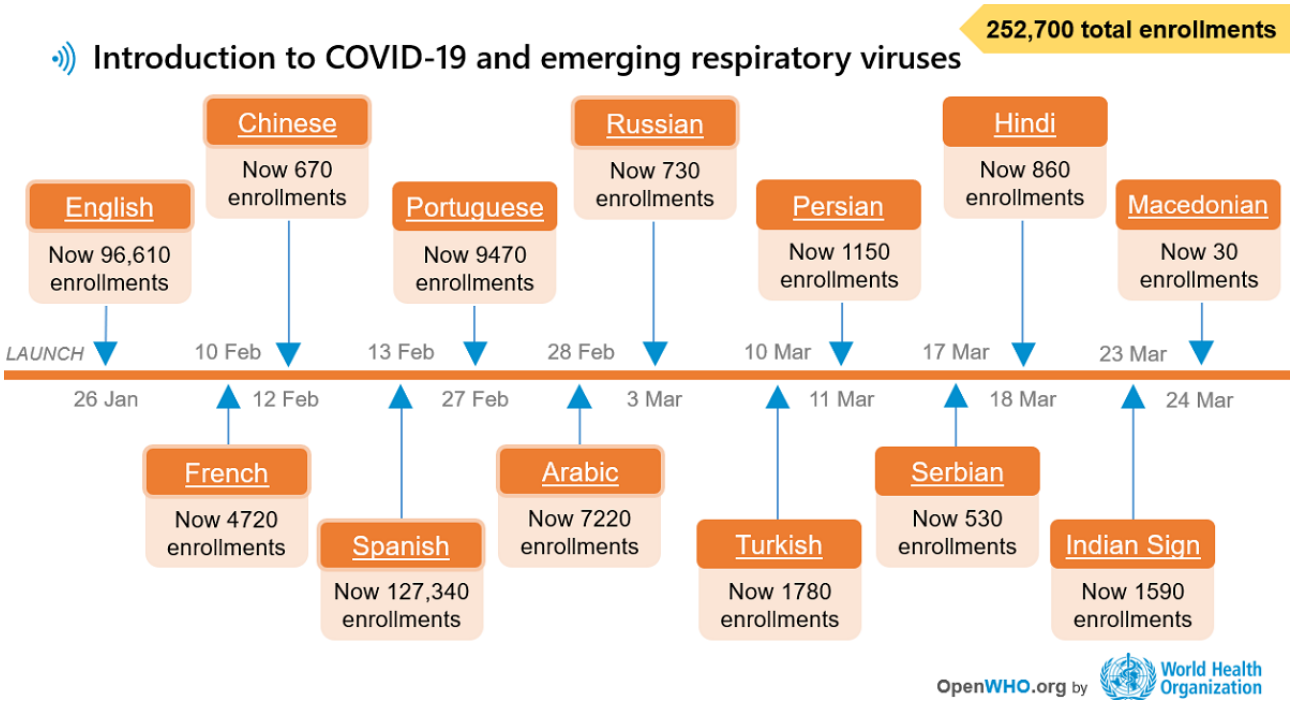
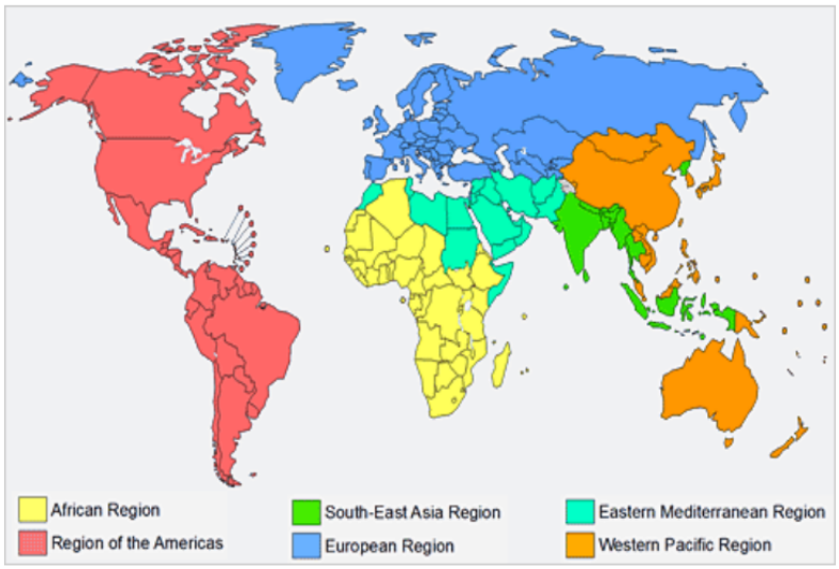


Figure 2. World Health Organization regions.



Relevant Literature

According to the WHO [1], "health literacy represents the cognitive and social skills that determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health." Research has found that the WHO is a respected source of accurate health information during epidemics, suggesting that the organization has a platform to shape health behavior, which less-trusted sources such as governments may lack [2]. The OpenWHO team has focused on designing knowledge transfer resources for health emergencies in formats and languages that are suitable for frontline responders and affected communities. This approach has prioritized multi-language production, recognizing that language can be a key obstacle to health literacy [3].

A 2015 study in Kenya by Translators Without Borders found that providing health information in Swahili—the lingua franca throughout the country—produced a significant increase in comprehension compared with providing the same information in English [4]. A 2019 study by the same organization, which partners with the WHO team on many translations, found that the local form of Swahili was the most effective language for risk communication and community engagement for the Ebola response in Goma, Democratic Republic of the Congo, compared with the French and standard Swahili languages [5]. Providing health information in individuals' native languages has also shown to improve knowledge about illnesses and medications in a patient population in Sri Lanka, as well as the

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understanding of oral health information among Vietnamese-speaking mothers in Australia [6,7].

Materials produced for OpenWHO are designed with additional accessibility considerations in mind. The resources are offered as downloadable slides that combine images and short texts, which can be read on a mobile device. Video and audio formats are also being integrated for those with strong oral cultures. In addition, the open-access nature of the platform can empower individuals who are more health literate to strengthen the health literacy of their communities, particularly in group-oriented societies. In a cholera-endemic neighborhood in Ghana, researchers found that household units impacted individual health literacy; nearly three-quarters of households surveyed followed suggestions from household members on how to prevent cholera [8].

By making materials from a reputable source available in multiple languages and in easily accessible, portable formats, OpenWHO's COVID-19 resources aim to contribute to improved health literacy.

Methods

This article investigates the geographic reach of different language courses accessed by the worldwide audience population while seeking health information on COVID-19. The users' professional identities are explored to inform the course owners on the use case. The course was developed and delivered via the learning platform OpenWHO.org. The self-paced introductory course was provided in a total of 13 languages between January 26 and March 25, 2020. The 13 languages were Arabic, Chinese, English, French, Hindi, Indian sign language, Macedonian, Persian, Portuguese, Russian, Serbian, Spanish, and Turkish.

This study's preliminary objective was to demonstrate the rapid surge of learners accessing the digitized learning materials as the COVID-19 epidemic grew into a pandemic during the early part of 2020. The aim of this study was to obtain a better understanding of the origin and type of people who sought access to online learning related to the emerging health crisis.

Statistical data for the identical courses in 13 languages were generated. More in-depth analysis was carried out on the English and Spanish language courses given the large use case in these two languages—89.20% (207,742/232,890) of all learners.

The data was collected from the online courses' statistical data and metrics reporting system on the OpenWHO platform. User patterns and locations were analyzed based on Google Analytics and the OpenWHO platform's own statistical capabilities, and data sets were overlaid.

This snapshot analysis was conducted based on user location with the data disaggregated according to the six WHO regions, the top 10 countries with the most users, and the proportion of use for each language version. Data included affiliation, gender, primary language, age, and other parameters for approximately 30% of users who indicated their background.

Results

Introductory COVID-19 Course User Metrics

During the first 2 months of the course's availability (January 26 to March 25, 2020), all 13 languages combined gathered 232,890 enrollments. The use of materials intensified after the declaration of the COVID-19 pandemic on March 11, 2020 (Figure 3).

The two most popular languages were the Spanish language course, which comprised half (n118,754/232,890, 50.99%) of all introductory COVID-19 course enrollments as of March 25, 2020, and the English language course, which comprised 38.21% (n=88,988) of enrollments. Despite being launched 2 weeks later, the Spanish version rapidly surpassed the original English course on March 19, 2020, becoming the main language driving the increase in enrollment. The English and Spanish course users jointly amounted to 210,000 users, representing 90.17% of all users across all language versions.

As expected, the number of accumulated enrollments across all language versions of the course rose steadily with each new language version launched (Figure 4).

In terms of user locations, the top 10 countries with the most users across all languages, accounting for (40,893/57,763) 70.79% of the total course users, were Ecuador (n=9521), Mexico (n=8236), Colombia (n=6137), Chile (n=4067), the United States (n=3836), Argentina (n=3609), Spain (n=1766), the United Kingdom (n=1499), India (n=1117), and Peru (n=925).

This makeup represents a marked shift in comparison with other top courses on the platform. For example, prior to the current outbreak of COVID-19, the platform's most popular emergency-related course, eProtect Ebola (offered in English and French), consisted primarily of users from Africa, Europe, and North America, with no South or Central American countries appearing in the top 20 for either language version of the course. This pattern reflected what was a general trend across the platform in the months preceding the launch of the introductory COVID-19 course; the platform's top 5 countries most commonly consisted of, in descending order, the United States, India, the United Kingdom, Portugal, and Nigeria, with only the presence of India breaking the aforementioned trend. As such, the launch of the introductory COVID-19 course has brought with it a change in the demographic of users on the platform, with a marked increase in traction from Central and South America.

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Figure 3. Introduction to coronavirus disease course use by language as of March 25, 2020.

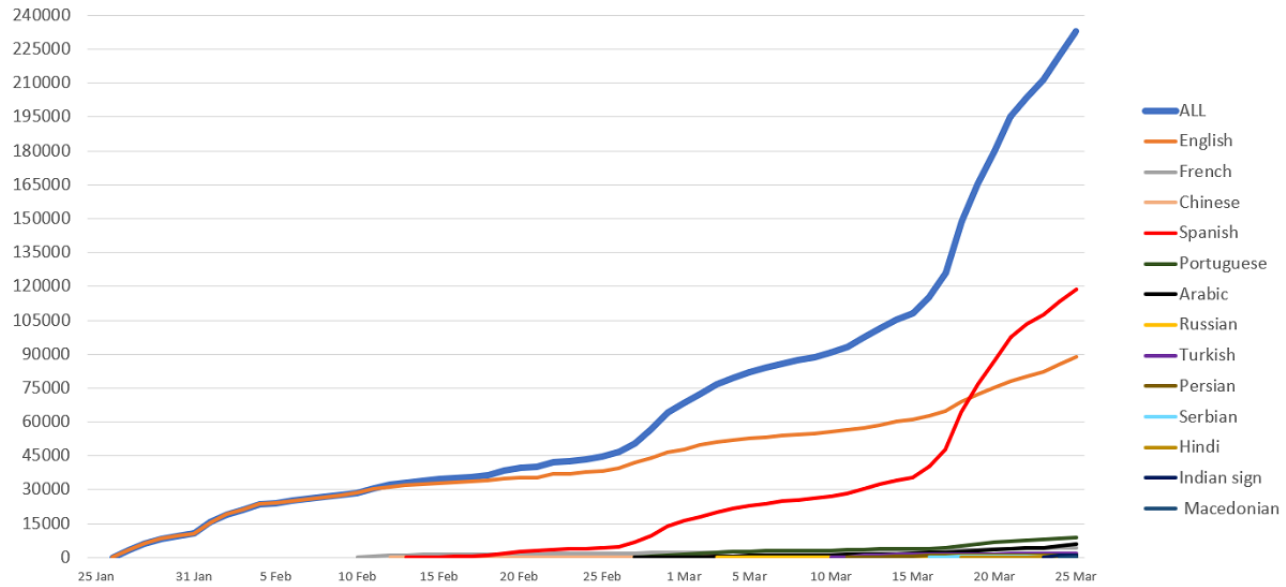
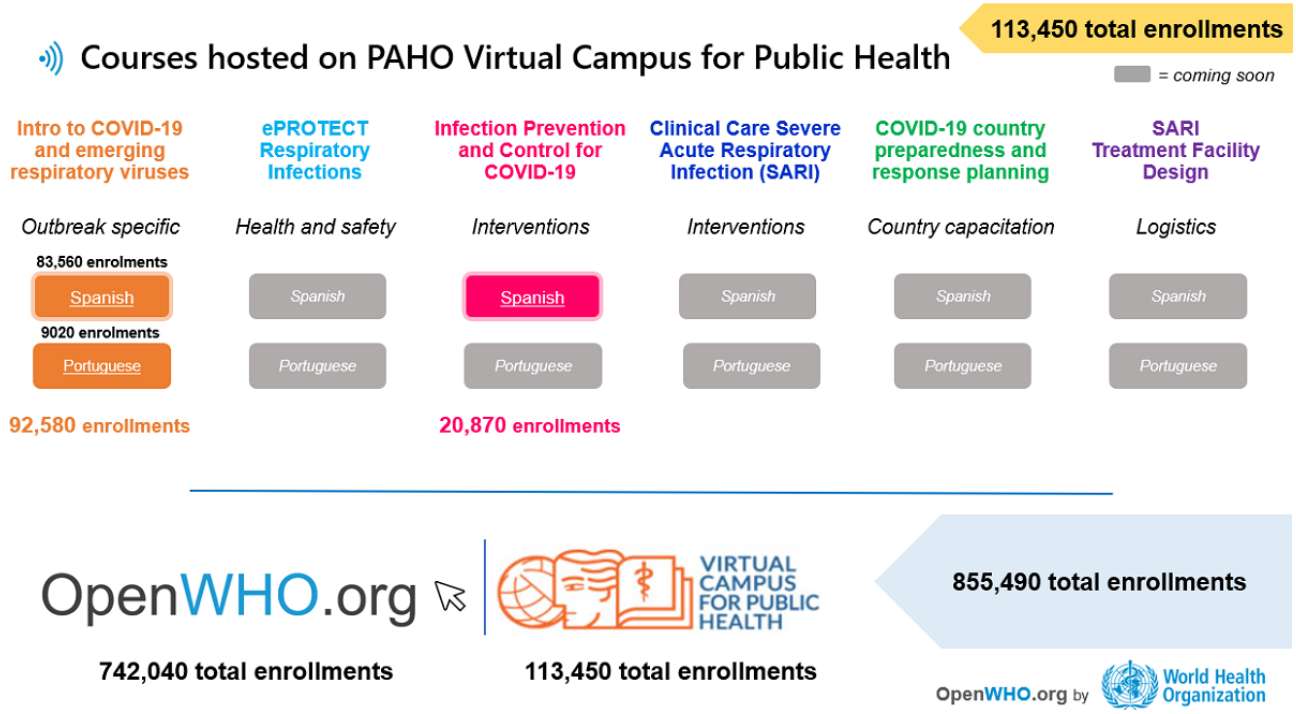


Figure 4. OpenWHO courses hosted on the Pan-American Health Organization virtual campus as of March 27, 2020. COVID-19: coronavirus disease.



Geographical Distribution of Users

The worldwide distribution of users is displayed in Figure 5 according to the WHO regions. The Region of the Americas accounted for most of the enrollments in the course, with more than (138,503/191,130) 72.47% of the total enrollments across all languages. Other regions were more evenly distributed: African Region (n=7643, 4.00%), Eastern Mediterranean Region (n=12,945, 6.77%), European Region (n=18,259, 9.55%), South-East Asia Region (n=7245, 3.79%), Western Pacific Region (n=5291, 2.77%), and territories (n=1244, 0.65%).

Users originating from the Region of the Americas accounted for over half of the enrollments in the Spanish language course. The second most popular language choice for users in the region was English, with a majority of English-course users enrolling from the United States of America, totaling more than a quarter (n=23,794/138,503, 28.75%) of the total English course users (Table 1).

Each language version provided interesting findings. The Serbian language course, for example, was used more in 4 other countries (Ecuador, Chile, Colombia, and Bosnia and Herzegovina) than it was in Serbia. The Indian sign language course attracted 1000 enrollments in the first 24 hours, with the largest use in the city of Baghdad, Iraq. Just after Portugal, the second top country for the Portuguese course was Mexico. For this version, almost as many enrollments came from Mexico City as from Lisbon. After Lisbon and Mexico City, 3 other

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Spanish-speaking cities were in the top 5 for the Portuguese version (Bogotá and Medellín in Colombia, and Quito in Ecuador), exceeding the numbers of enrollments from any other Portuguese-speaking city. São Paulo and Rio de Janeiro (Brazil) were the sixth and seventh top cities, respectively, for the Portuguese version of the course. For the French course, the third top city was not French-speaking as one would expect; Mexico City came right after Paris, France, and Bukavu, Democratic Republic of the Congo.

The introductory course was the most popular in the Region of the Americas, with almost three-fourths of the total enrollments across all languages concentrated in this region. This trend might be explained in part by the language availability of the course for the first month, which was limited to English and Spanish along with the French and Chinese versions (Figure 1). Totaling 54.00% (103,207/191,130) of the total course enrollments, the Spanish version had 95.53% (98,554/103,207) of its enrollments from the Region of the Americas. With 37.03% (70,774/191,130) of the total course enrollments, the English version had 46.39% (32,841/70,774) of its enrollments from this region. The latter statistic speaks to the more even distribution of the 70,744 enrollments in the English language course across the other WHO regions: African Region 8.44% (n=5975), Eastern Mediterranean Region 12.15% (n=8597), European Region 15.82% (n=11,194), South-East Asia Region 9.24% (n=6539), Western Pacific Region 6.96% (n=4924), and the territories 0.99% (n=704). Even taking into consideration the gradual release of the language versions' impact on these statistics, it is worth noting that no other languages had similar slopes as those seen for the Spanish and English versions (Figure 3).

The European Region came second with 9.55% (18,259/191,130) of the total enrollments, mainly distributed between the English (11,194/18,259, 61.31%) and Spanish (n=3942, 21.59%) versions of the course. The Eastern Mediterranean Region comprised 6.77% (12,945/191,130) of the total enrollments, mainly distributed between the English (n=8597/12,945, 66.41%) and Arabic (n=3419, 26.41%) versions. These proportions might also be explained by the release of the Arabic version 1 month after the English version. The African and South-East Asia regions each made up about 4% of the total enrollments, with the main language versions used being English (5975/7643, 78.18%) and French (n=1255, 16.42%) for the African Region and primarily English (6539/7245, 90.25%) for the South-East Asia Region. This was similar to the Western Pacific Region, which comprised of 2.77% (5291/191,130) of the total course enrollments. The English course was accessed by 93.06% (4924/5291) of the enrollments in this region. The territories comprised 0.65% (1244/191,130) of the total course enrollments, also mainly using the English (704/1244, 56.59%) and Spanish (n=341, 27.41%) versions.

Figure 5. Users from the top 10 countries and their affiliations. GOARN: Global Outbreak Alert and Response Network; NGO: nongovernmental organization; WHO: World Health Organization.

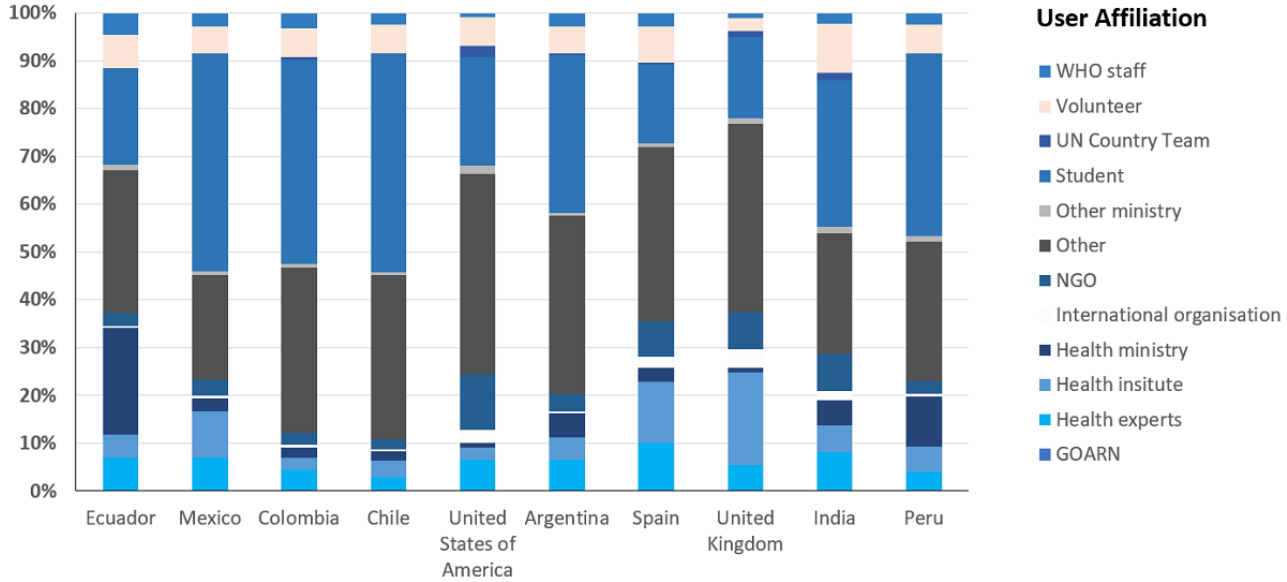

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Table 1. Introductory course use overview by World Health Organization region and language used for course enrollments (N=191,130).

Region	Total, n (%)	English, n (%)	French, n (%)	Russian, n (%)	Hindi, n (%)	Spanish, n (%)	Persian, n (%)	Portuguese, n (%)	Serbian, n (%)	Turkish, n (%)	Arabic, n (%)	Chinese, n (%)
All regions	191,130 (100.00)	70,774 (37.03)	3398 (1.78)	486 (0.25)	348 (0.18)	103,207 (54.00)	716 (0.37)	5934 (3.10)	296 (0.15)	1274 (0.67)	4208 (2.20)	489 (0.26)
AFRO[a]	7643 (4.00)	5975 (3.13)	1255 (0.66)	3 (0.00)	3 (0.00)	97 (0.05)	36 (0.02)	123 (0.06)	6 (0.00)	63 (0.03)	68 (0.04)	14 (0.01)
AMRO[b]	138,503 (72.47)	32,841 (17.18)	915 (0.48)	98 (0.05)	10 (0.01)	98,554 (51.56)	193 (0.10)	4899 (2.56)	193 (0.10)	462 (0.24)	188 (0.10)	150 (0.08)
EMRO[c]	12,945 (6.77)	8597 (4.50)	284 (0.15)	15 (0.01)	10 (0.01)	137 (0.07)	264 (0.14)	56 (0.03)	21 (0.01)	112 (0.06)	3419 (1.79)	30 (0.02)
EURO[d]	18,259 (9.55)	11,194 (5.86)	821 (0.43)	354 (0.19)	5 (0.00)	3942 (2.06)	156 (0.08)	806 (0.42)	68 (0.04)	456 (0.24)	395 (0.21)	62 (0.03)
SEARO[e]	7245 (3.79)	6539 (3.42)	71 (0.04)	11 (0.01)	313 (0.16)	72 (0.04)	39 (0.02)	28 (0.01)	7 (0.00)	128 (0.07)	16 (0.01)	21 (0.01)
WPRO[f]	5291 (2.77)	4924 (2.58)	31 (0.02)	5 (0.00)	7 (0.00)	64 (0.03)	22 (0.01)	20 (0.01)	1 (0.00)	48 (0.03)	19 (0.01)	150 (0.08)
Territories	1244 (0.65)	704 (0.37)	21 (0.01)	0 (0.00)	0 (0.00)	341 (0.18)	6 (0.00)	2 (0.00)	0 (0.00)	5 (0.00)	103 (0.05)	62 (0.03)

[a]AFRO: African Region.

[b]AMRO: Region of the Americas.

[c]EMRO: Eastern Mediterranean Region.

[d]EURO: European Region.

[e]SEARO: South-East Asia Region.

[f]WPRO: Western Pacific Region.

Spanish Course Use Case

The highest Spanish course use was in Ecuador (n=36,345), Mexico (n=26,141), Colombia (n=19,733), Chile (n=11,793), and Argentina (n=11,711). The highest English course use was in the United States (n=12,250), Mexico (n=7659), Ecuador (n=5805), India (n=5296), and the United Kingdom (n=4052), with Colombia and Argentina also making it to the top 10.

Of the total users who indicated their language of preference, 61.45% (60,800/98,937) selected Spanish. This language preference helps the OpenWHO team further target the courses and prioritize languages. The other preferred languages selected were English (n=31,837, 32.18%), French (n=2369, 2.39%), Portuguese (n=1374, 2.17%), Arabic (n=1374, 1.39%), Russian (n=249, 0.25%), and Chinese (n=160, 0.16%).

The indicated language preference correlated with the language course use; however, as the option for the preferred language only included the six UN official languages and Portuguese, the OpenWHO team was not able to capture if there were any national or local languages popular in addition to the official UN languages.

The same introductory course was published on the Pan-American Health Organization's (PAHO) virtual campus (VC) in Spanish on February 11 and in Portuguese on February 28, 2020. This paper and the data exclude the 92,000 users of these identical courses on the PAHO VC, which would bring the merged worldwide user numbers even higher (Figure 4).

User Background Information

Before the COVID-19 pandemic, users were spread over the 11 distinct affiliation options provided by the platform, with a small fraction of users identifying themselves as "Other." With the epidemic accelerating into a pandemic, the largest number of the COVID-19 introductory course users selected "Other," suggesting a large number of users who were not health professionals or academics. Students were the largest identifiable group among those who indicated their affiliation. Health ministries and health experts made up 14.21% (7417/52,214), and UN country teams and WHO staff amounted to 4.00% (n=2087; Table 2).

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Table 2. Users' professional affiliations for the total users who specified their professional affiliation (n=52,214).

Affiliations	Users, n (%)
Other	16,527 (31.65)
Student	14,945 (28.62)
Health ministry	4243 (8.13)
Volunteer	3330 (6.38)
Health experts	3174 (6.08)
Health institute	3141 (6.02)
Nongovernmental organization	2981 (5.71)
World Health Organization staff	1525 (2.92)
International organization	995 (1.91)
Other ministry	730 (1.40)
UN country team	562 (1.08)
Global Outbreak Alert and Response Network	61 (0.12)

When looking at the top countries and user affiliations in Figure 5, students accounted for a large proportion of the users coming from those countries. For Chile, Colombia, and Mexico, for instance, students represented 45.66% (1857/4067), 42.85% (2707/6317), and 45.70% (3764/8236), respectively, of the total enrollments. As mentioned earlier for the overall analysis, Figure 5 shows that many users were not affiliated with a specific health background. If we examine the figure, we find that the percentage of users who selected "Other" as their affiliation varied from 21.90% (1803/8236) in Mexico to 39.22% (588/1499) and 41.82% (1604/3836) in the United Kingdom and the United States, respectively. Health institutes were also represented in the affiliations for the users in the top 10 countries. The share of health institute workers was the highest for the United Kingdom at 19.48% (292/1499). Another interesting finding was the attraction of health ministry representatives, especially significant for Ecuador, as they represented 22.27% (2120/9521) of the total users for the country. Besides Ecuador, Peru (96/925, 10.37%) is the only other country reporting enrollments from health ministry professionals that reached at least 10%. Other health experts also enrolled in the course; they represented, for instance, 9.85% (174/1766) of the total enrollments reported from Spain. Volunteers were also represented in all of the top 10 countries, with India reporting the highest percentage of this specific user affiliation in 10.29% (115/1117) of its enrollments.

The course registrations also suggested that women (33,216/57,712, 57.55%) were a larger user group than men (n=24,383, 42.25%). In addition, 0.20% (113) of users identified as "Other".

When comparing the English and Spanish course age groups (Figures 6 and 7), the Spanish course had a large cohort of participants who were 70 years or older, which was much higher than the platform average or the English course. As COVID-19 was stated to be impacting older people the most, this use case comes as no surprise. On average, the English course had a younger use case than the platform average, especially in the age groups 30-39 years and 40-49 years.

Figure 6. English course use by age groups.

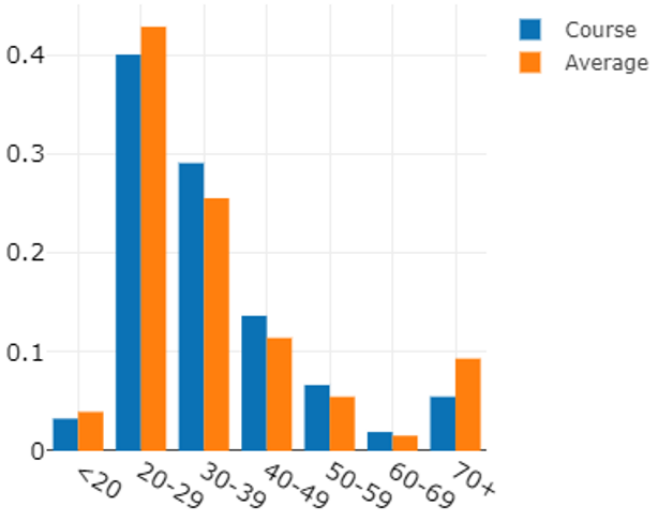

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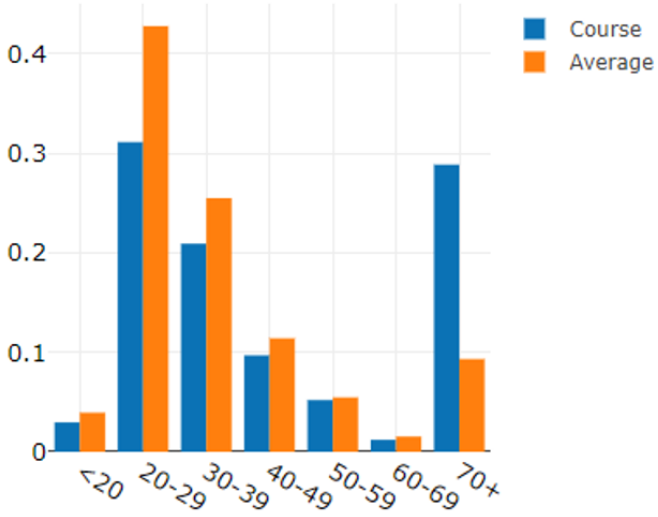
Figure 7. Spanish course use by age groups.



Spanish and English Courses and Completion Rates

A total of 36.43% (14,382/39,475) of participants that enrolled in the Spanish introductory course completed all six learning items within the course. In comparison with industry standards, which place the completion rate for massive open online courses (MOOCs) at 7.40% (3700 completions per 50,000 enrollments) [9], this rate is high. Again, in relation to the Spanish introductory course, 44.66% (17,630/39,475) of the participants completed at least 80.00% of the course material, and 49.09% (n=19,377) visited at least 60.00% of the course material. When the completion rate was calculated across all language versions of the course, this trend continued, with 21.63% (16,003/73,980) of users visiting 100.00% of the course items, 27.62% (n=20,433) visiting at least 80.00%, and 32.54% (n=24,075) of users visiting at least 60.00% of the total learning resources in the course.

Participants enrolled in the English version did not perform as well. Only 2.94% (813/27,639) of the participants who enrolled in the English course completed all course material, and only 6.61% (n=1828) completed at least 80.00% of the course material, and 16.65% (n=4603) visited at least half of all course items. Further investigation is required to determine the cause of the discrepancy between the completion rates for the English version of the course compared with the completion rate across all language versions combined. Unlike the subsequent language versions, the English introductory COVID-19 course was assembled over a period of several weeks, with new materials being made available as they were constructed and cleared by the technical experts responsible. In contrast, most of the subsequent language versions were launched as full packages with all course items available at once. This difference could begin to explain the discrepancy in completion rates, as the first set of users who enrolled in the English course would have had to return to the course at later dates to view new material as it was added.

Platform User Surge During the Early Weeks of the COVID-19 Pandemic

Since the launch of the first course related to COVID-19 on OpenWHO on January 26, 2020, the number of unique learners on the platform increased seven times, from 90,700 unique learners to 629,500 as of March 25. The introductory course brought the largest number of new learners along with the Infection Prevention and Control for COVID-19 course.

In the 2.5 years of operations prior to the coronavirus pandemic of 2020, outbreak-related learning resources were each used by thousands of users, with some courses such as eProtect occupational health and safety for Ebola and Antimicrobial Stewardship reaching up to 20,000-30,000 users over 2 years of the course's life span. The two most popular COVID-19 courses (Introduction and Infection Prevention and Control) attracted more than 200,000 learners each in less than 2 months.

Before COVID-19, there were on average some 100 course enrollments per day. During the first months of 2020, there were some 10,000-20,000 enrollments per day, with sharply increasing figures reaching up to 50,000 new learner registrations the week of the pandemic declaration (Figure 8). This testifies to the essence of OpenWHO offering health-related technical knowledge to frontline responders and the general public as an open and scalable solution for the fast distribution of lifesaving content in disease outbreaks and, in particular, during a pandemic.

OpenWHO has been working in full support of COVID-19 preparedness and response with the timely upload of learner resources, which was characterized by an accelerated process to make different language versions of the learning materials rapidly available. There was also an emphasis on quickly delivering the key available technical and operational information. Including the introductory COVID-19 course, a total of six courses were produced fully or partially in 40 different languages in the first quarter of 2020 (Figure 9).

During the early part of the coronavirus epidemic and pandemic, platform use shifted from health professionals and experts to largely non-health-related audiences. Between January 26 and

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February 25, 2020, OpenWHO expanded from some 80,000 existing unique users to 160,000, doubling the number of learners. From February 26 to March 25, 2020, the unique user numbers almost quadrupled to 600,000. Including the enrollments in the same courses hosted on PAHO's VC platform, there were more than 840,000 enrollments in all of the COVID-19 courses.

After the declaration of the pandemic on March 11, 2020, the number of unique learners on the platform nearly tripled in 2 weeks, from 235,250 users to 629,500 users as of March 25. The increase from March 11 to March 25, 2020, consisted of a total of 394,250 new learners in merely 14 days. This number is more than four times higher than the 90,700 total users on the platform from 2017 to 2019 (Figure 10).

Figure 8. OpenWHO accumulated enrollments from June 30, 2017, to March 27, 2020. COVID-19: coronavirus disease.

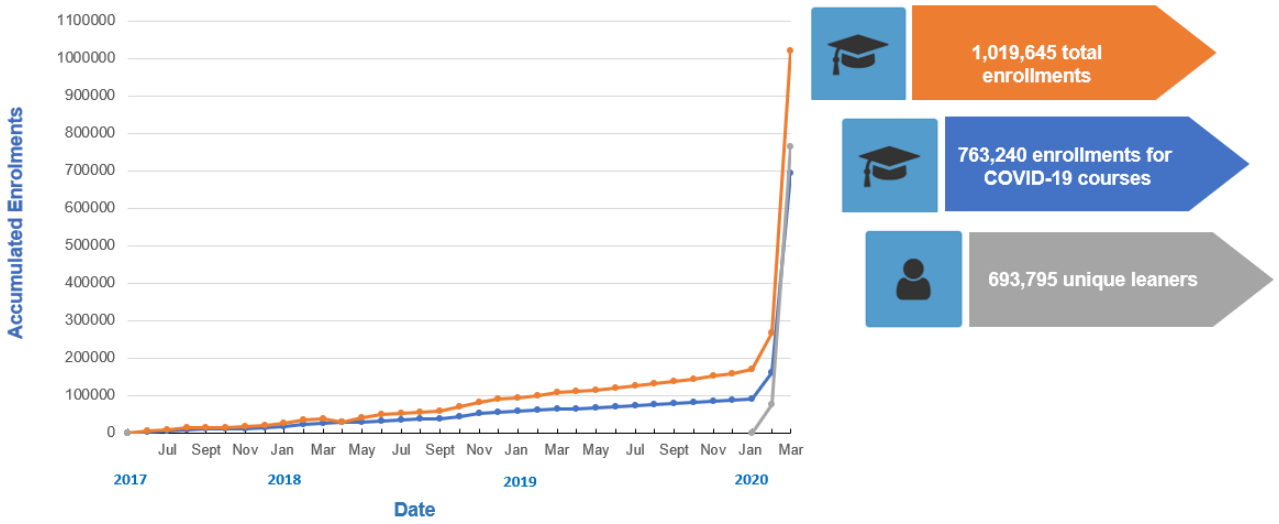

Figure 9. OpenWHO courses related to COVID-19 and language versions as of March 27, 2020. COVID-19: coronavirus disease.

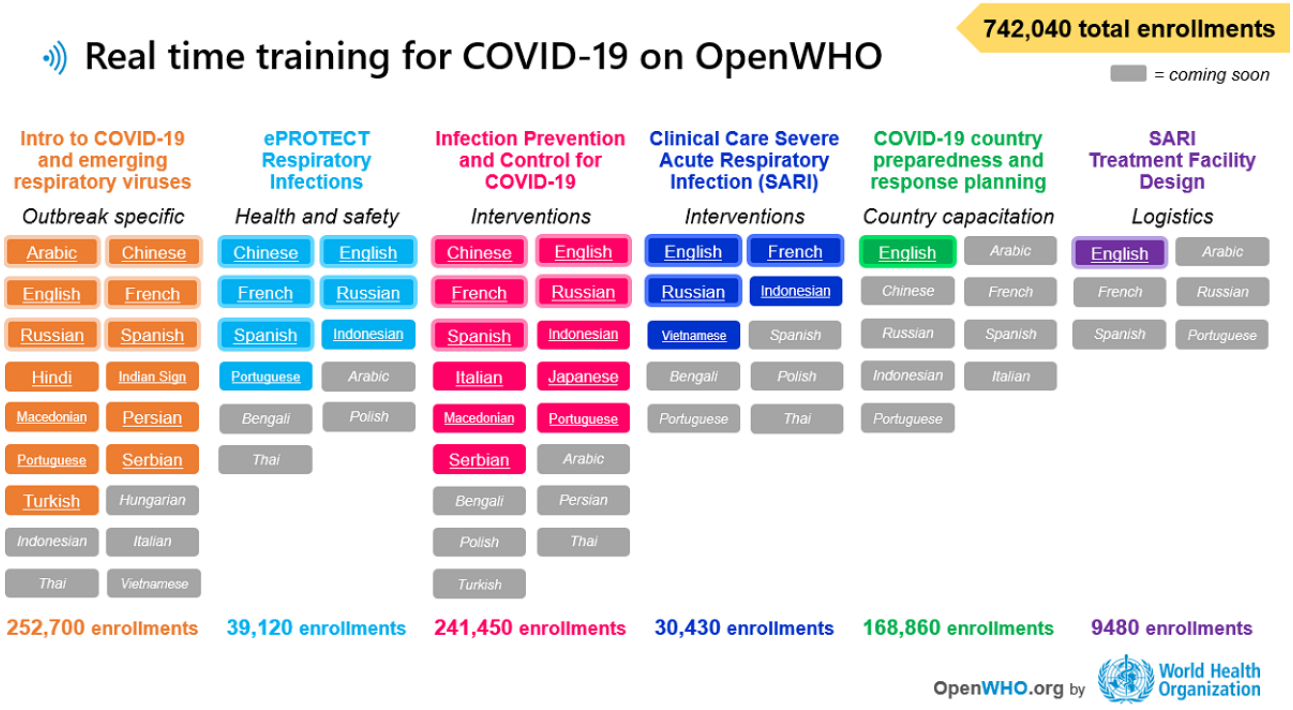

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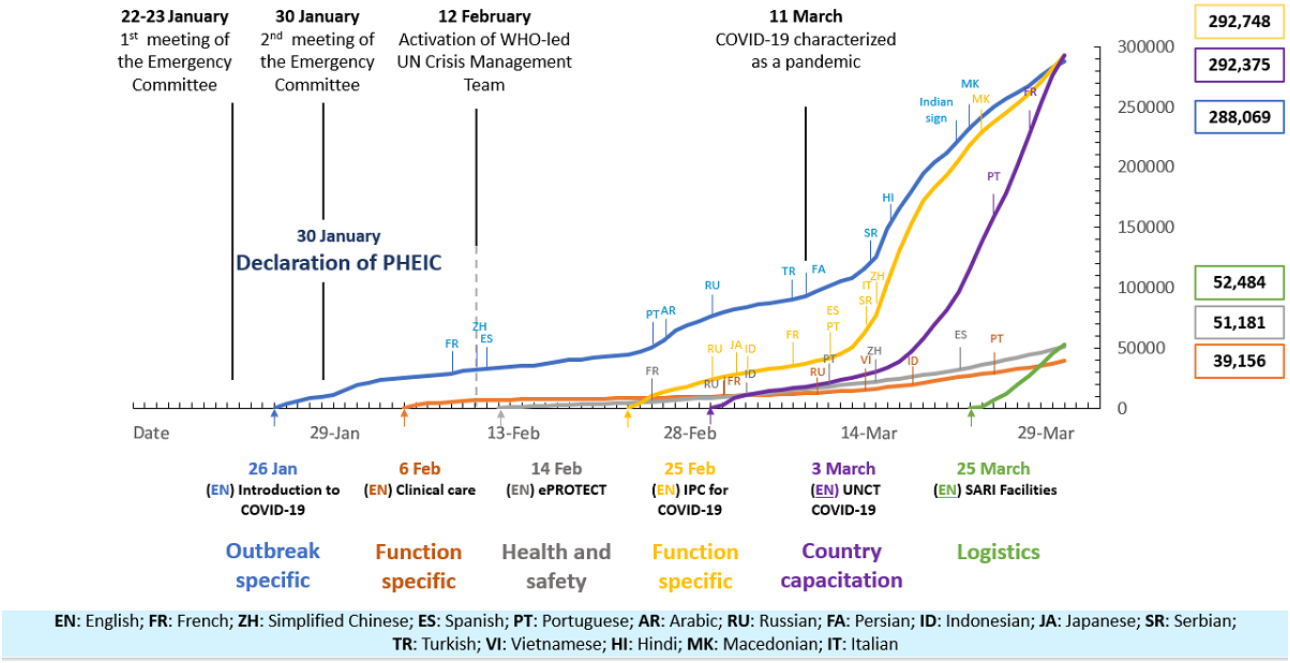
Figure 10. Timeline of all OpenWHO.org COVID-19 courses' launch and use. COVID-19: coronavirus disease; IPC: infection prevention and control; PHEIC: Public Health Emergency of International Concern; SARI: severe acute respiratory infection; UNCT: UN country teams; WHO: World Health Organization.



Discussion

Principal Findings

The OpenWHO learning resources are usually initially published in English, as this language is shared by many native and nonnative speakers across the world and is the most commonly used working language of the UN system. Recent trends seen on the platform during the pandemic, notably the popularity of the Spanish versions of the COVID-19 resources surpassing that of the original English courses, stressed the importance of a multilingual learning platform that allows learners to access information in the language they are the most comfortable using. This has been a continuous effort since the platform's inception, with courses even produced in local languages for localized emergencies. During the Ebola outbreak in the Democratic Republic of the Congo, for example, the Ebola knowledge resources for the responders course was published in Lingala and Swahili.

This multilingual approach is even more important in the middle of a pandemic, where OpenWHO is experiencing record-breaking enrollments from learners across the world who are seeking the latest WHO guidance to support the preparation and response to COVID-19. Indeed, in its first 2 months, the introductory course to COVID-19 comprised more than a quarter (n=241,749) of the accumulated total enrollments on a platform that has been running since June 2017. The analysis also indicated that substantial numbers of people were using the resource in languages other than the national languages of the countries in which they were located, suggesting that the platform provides a service that local governments may not be able to offer. With diaspora populations scattered across the world, the ability to access material in one's native language irrespective of location is important.

The geographic analysis demonstrated that the enrollment surge for this emergency-related course mainly originated from Central and South America, with Ecuador, Mexico, Columbia, Chile, and the United States rounding out the top 5 countries, reflecting a new demographic that is attracted to the platform. Interestingly, the age distribution analysis for the Spanish course, with enrollments mainly concentrated in the Region of the Americas (n=98,554/103,207, 95.49%), revealed the popularity of the course with those 70 years or older compared with the other courses hosted on the OpenWHO platform. This is consistent with the at-risk group seeking reliable knowledge on the emerging respiratory disease. Prior to the pandemic, the top countries for OpenWHO's most popular emergency courses were on the African continent, along with recurrent appearances by the United States and India, as these populous countries are big MOOC users.

This geographic shift is consistent with the nature of a pandemic. Rather than affecting specific parts of the world, as was the case for the 2014 Ebola outbreak, for example, the COVID-19 epidemic has accelerated into a pandemic reaching almost every country on the planet.

In contrast with the top emergency courses prior to the COVID-19 outbreak, the analysis also revealed that nearly 30% of users indicated that they were not affiliated with the student and professional health sectors (n=16,527/52,214, 31.65%). This shift reflects the impact a pandemic has on the audience profile, with the general public enrolling in the course to become informed on the novel coronavirus. It also suggests that OpenWHO can serve as one mechanism to help combat the "infodemic" of misinformation that has occurred during the COVID-19 outbreak [10]; research has found that many people turn to the internet for health information, including during crises, and the information they find can influence health behaviors [11-13].

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OpenWHO hit the 1 million enrollments milestone on March 27, 2020. About three-quarters of the total enrollments were on the courses related to COVID-19. This reflects a massive increase in the popularity of OpenWHO and the critical role it is playing in supporting preparedness and response during this unprecedented pandemic. As the outbreak continues to evolve, new resources and language versions will be added to the platform to provide lifesaving knowledge to affected communities, and existing courses will be updated to best reflect the changing contexts.

Limitations and Future Research

This analysis was limited to the 2-month period following the launch of the introductory COVID-19 course on OpenWHO. Data such as affiliation, gender, and age were only available for 32.43% (52,214/161,007) of the users who indicated their background. The geographical data was based on the users' internet protocol addresses, which would not account for potential manipulation by virtual private networks or other factors. In addition, completion rates were measured by user visits to each of the course's learning items, as quizzes were not yet implemented due to the evolving nature of the emergency guidance.

Future research should examine the use case of additional COVID-19 courses on the OpenWHO platform that are more targeted to specific audiences, such as courses designed for clinicians and public health professionals. Data should also be analyzed against the worldwide, regional, and country-level epidemic curves for COVID-19 to identify broader use trends, including how the use case evolved throughout the pandemic, as different regions were more or less affected.

Conclusions

During health emergencies, lifesaving information must be packaged and delivered in the languages spoken by the target audiences to effectively transfer urgent knowledge [4,5]. Everyone has the right to access lifesaving knowledge, and OpenWHO is continuing to work with partners to make its resources available in as many languages as possible. The OpenWHO team has never before experienced such high levels of volunteerism for platform language production and has relied on crowdsourcing across the world to publish additional language versions. This has promoted the localization of materials into a variety of languages, helping people better protect themselves and fight the pandemic.

The OpenWHO platform offers courses on six distinct topics to support the COVID-19 response. These are products that transform the WHO guidance into learning packages that users can grasp and digest more easily. The courses have been translated and published fully or partially into 40 language versions during the first 2 months of the response, and OpenWHO has experienced an unprecedented increase in platform use. Amidst huge demand for reliable resources that offer the knowledge to understand and decipher the evolving situation, OpenWHO has served as one source of digitized information.

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Conflicts of Interest

None declared.

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Abbreviations

COVID-19: coronavirus disease
MOOC: massive open online course
PAHO: Pan-American Health Organization
WHO: World Health Organization
VC: virtual campus

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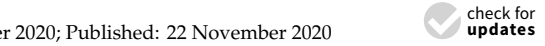

Abstract: On 11 March 2020, the World Health Organization (WHO) declared the outbreak of coronavirus disease (COVID-19) to be a pandemic. As a result, the OpenWHO.org online platform, which serves as WHO's learning hub for emergencies, was tested for the first time on its core purpose of scaling up trusted public health information in a global emergency. This descriptive study examines and documents the WHO learning response in the early months of the pandemic by comparing epidemiological information and OpenWHO.org use in the countries with the highest COVID-19 cases. Statistical datasets from OpenWHO.org and WHO's COVID-19 dashboard were overlaid for the period 11 March–22 May 2020. During this period, for most of the 24 countries with the highest COVID-19 cases, platform use showed a corresponding trend. Courses published in the official languages spoken in these countries were well utilized, indicating a need to produce materials in languages spoken by affected communities. Of the countries with the highest number of users on OpenWHO, only half were top users of the platform before the pandemic. The existence of an established online platform for health emergencies assisted WHO in massively and quickly scaling up the dissemination of essential learning materials for COVID-19.

Keywords: COVID-19; pandemic; online learning; OpenWHO; WHO

1. Introduction

The COVID-19 pandemic has affected nearly every country on the planet. The demand for trustworthy information has surged as the virus has spread. As restrictions on travel and physical distancing measures were put into place across the globe, those affected began searching online for information about coronavirus disease [1]. OpenWHO, the WHO Health Emergencies Programme's learning platform, which previously focused on infectious disease work mainly in the Global South, expanded in use throughout the world. In just 10 weeks after WHO declared a Public Health Emergency of International Concern (PHEIC) on 30 January 2020, the platform witnessed course enrolments jump from 177,209 to 1,596,892, an increase of 801.14% [2].

OpenWHO was created in 2017 with emergencies like COVID-19 in mind. During a pandemic, WHO needs to reach millions of people across the globe with real-time learning materials. Courses need to be accessed easily in low bandwidth settings or even where there is no internet [3]. Knowledge must be presented in easy-to-use formats [4]. The self-paced format affords interested learners the flexibility to take courses at their own pace [5].

Research suggests that open online learning, including the fast delivery of knowledge in the context of disease outbreaks, can contribute to public health capacity building [6–9]. Further, a 2018

study from Mexico indicates that people have an increased interest in learning when confronted with an emergency [9]. A pandemic is usually caused by a novel pathogen, which means that much of the knowledge needed to respond did not exist previously. For COVID-19, WHO experts fast-tracked the development of learning material to support the response and launched the first course for COVID-19 on OpenWHO on 26 January 2020, four days before the PHEIC declaration.

While some studies on learning during COVID-19 have emerged, there are no systematic or meta-analyses, including research protocols, focusing on online learning and COVID-19 [10–15].

Some studies refer to mass communication for specific groups, such as youth, through social networks as an efficient method of health-related information dissemination during periods such as lockdowns [16]. Research also suggests that "the Internet is used for adult education in most professional domains, but its use for continuing medical education is less developed" [17], and that Massive Open Online Courses (MOOCs) foster the dissemination of educational content and research results at a large scale and also enable collaborations [18].

MOOCs generally refer to online classes or lectures that offer unlimited registration for anyone who wants to participate, with the open nature differentiating MOOCs from online courses offered for academic credit [7–9]. Although they have been found to have low retention rates and appear to be more popular among participants in North America and Europe, MOOCs also have the potential to make quality educational resources available across geographical and social boundaries, with particular benefit to students in developing countries who otherwise may not have access to such resources [19]. Healthcare MOOCs are useful for a variety of populations, from the general public to specialized and highly experienced professionals, especially during social isolation [20].

For OpenWHO, an immediate priority was making resources available in multiple languages, as research suggests that people prefer online materials in their own language whenever possible, including when searching for health information [21,22]. Further, a 2017 study of MOOCs about disease outbreaks found that translation into more languages could improve participation and traction among affected communities [8]. In order to support the emergency response, a total of 67 courses in 22 languages were quickly delivered during the two months following the pandemic declaration on 11 March 2020.

This study focuses on the use of OpenWHO.org. It examines its use in the countries with the highest number of COVID-19 cases in the 10 weeks following the pandemic declaration, as well as the changes in patterns of use before and after the COVID-19 outbreak.

2. Materials and Methods

This descriptive study documents some of the trends characterizing the global audience reached by OpenWHO's open online COVID-19 courses. The aim of this study was to gain a better understanding of the audience that sought access to the WHO learning materials during the coronavirus pandemic. The users' metrics, including location, gender, language, age, and affiliation, are explored to inform the use case of these open online courses and identify the variations in use driven by the pandemic, thus, documenting the platform's first-ever public health digital response in the face of a global pandemic. This study also investigates the use of the OpenWHO COVID-19 digitized learning materials in the areas most affected by the virus to assess the efficacy of the geographic reach of these open online resources.

Anonymized statistical datasets were obtained from the OpenWHO integrated reporting system, providing platform-wide, topical, and course-specific (language version) datasets. As of 22 May 2020, OpenWHO offered 10 COVID-19 response-related topics, with most available in several languages: (1) Emerging respiratory viruses, including COVID-19: methods for detection, prevention, response, and control; (2) ePROTECT Respiratory Infections; (3) Infection Prevention and Control (IPC) for COVID-19 Virus; (4) WHO Clinical Care Severe Acute Respiratory Infection Training; (5) COVID-19: How to put on and remove personal protective equipment (PPE); (6) Standard precautions: Hand hygiene; (7) Severe Acute Respiratory Infection (SARI) Treatment Facility Design; (8) COVID-19:

Operational Planning Guidelines and COVID-19 Partners Platform to support country preparedness and response; (9) Standard precautions: Waste management; and (10) Introduction to Go.Data-Field data collection, chains of transmission and contact follow-up.

Additional linguistic analysis was conducted on the most popular and translated resource, the introductory course: Emerging respiratory viruses, including COVID-19: methods for detection, prevention, response and control; this was OpenWHO's first COVID-19 course, which was published on 26 January 2020, and totaled 459,412 enrolments as of 22 May 2020. Analysis was conducted to assess enrolment proportions in the 22 languages in which it was available and to examine the top language versions used by countries most affected by the pandemic. This informs the relevance of the multilingual aspect of a public health knowledge transfer endeavor.

Course users' OpenWHO activity by geographic location was captured by Google Analytics. A user's activity was measured by web session; with an active session defined as the period of time a user is actively engaged with the OpenWHO platform (via desktop, mobile, or app). The statistical dataset obtained on OpenWHO usage was overlaid with a statistical dataset from the WHO Health Emergencies Programme COVID-19 dashboard, including the countries with the highest number of COVID-19 cases from 11 March–22 May 2020 [23].

Microsoft Excel was used to conduct the user analysis to provide descriptive statistics assessing user metrics and patterns. Frequencies were calculated for the following variables: affiliation, gender, language, age, and geographic location by country and aggregated by WHO regions. This information is disclosed by the learner during the registration process for the OpenWHO platform. The patterns identified help characterize the trends within this global audience. Further analysis of exceptional online user groups, such as 70+ year-old users, was performed to investigate their specific use of the COVID-19 online resources.

3. Results

3.1. Countries with the Highest Number of COVID-19 Cases and Use of the OpenWHO Platform

As the COVID-19 epidemic grew, the need for learning materials surged accordingly. The countries that experienced the highest numbers of confirmed COVID-19 cases during the 10-week period following the pandemic declaration (11 March–22 May 2020) also had a similar number of users on OpenWHO (Figure 1). The only major exceptions were the USA and India where the two figures diverged more significantly. In the USA, the case count was the highest globally, and use of OpenWHO was also high in comparison to other countries. India has historically exhibited the greatest use of OpenWHO both before and after the pandemic declaration. With an already high number of users before the pandemic, OpenWHO use in India remained elevated during the pandemic, making up 15% of the total use of the platform.

While most of the countries in this list experienced similar levels of COVID-19 cases and OpenWHO platform use, Russia and China exhibited the lowest platform use despite their COVID-19 cases. Users from these countries have not historically been active users on OpenWHO, nor have there been materials in their languages on the platform before the pandemic, with the exception of one course in Russian. There is also a barrier to accessing the platform in China, as the platform's webpages are not accessible to China-based users. The number of users in Brazil, the UK, Italy, and Spain is similar to the COVID-19 case count.

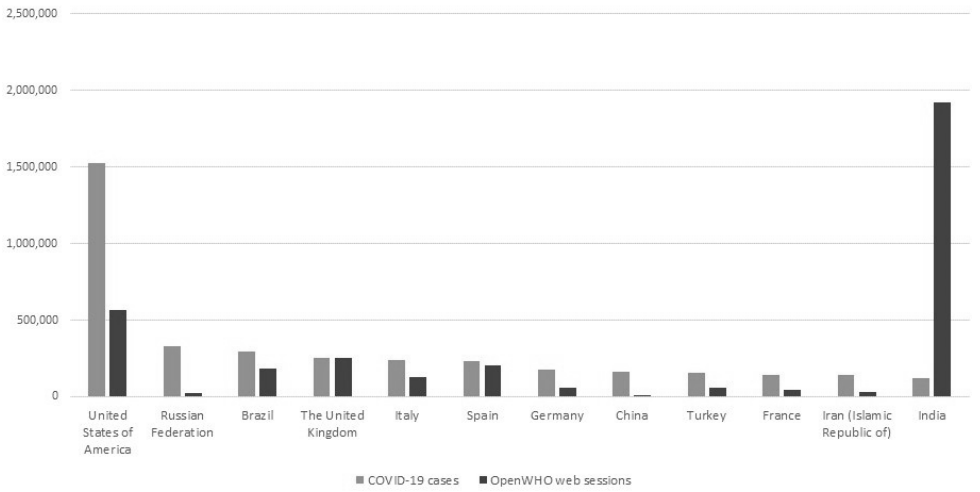

Figure 1. OpenWHO web sessions in the 12 countries with the highest cumulative confirmed COVID-19 cases (11 March–22 May 2020).

The countries with the 13th to 24th highest cumulative confirmed COVID-19 cases (Figure 2) largely differ in trend to those in Figure 1. OpenWHO use in Peru, Canada, Saudi Arabia, Mexico, Chile, Pakistan, and Ecuador is high, with all countries featuring among the top 24 countries with regard to OpenWHO use after the pandemic declaration. Belgium, The Netherlands, Qatar, and Sweden, on the other hand, show a similar trend to most countries illustrated in Figure 1.

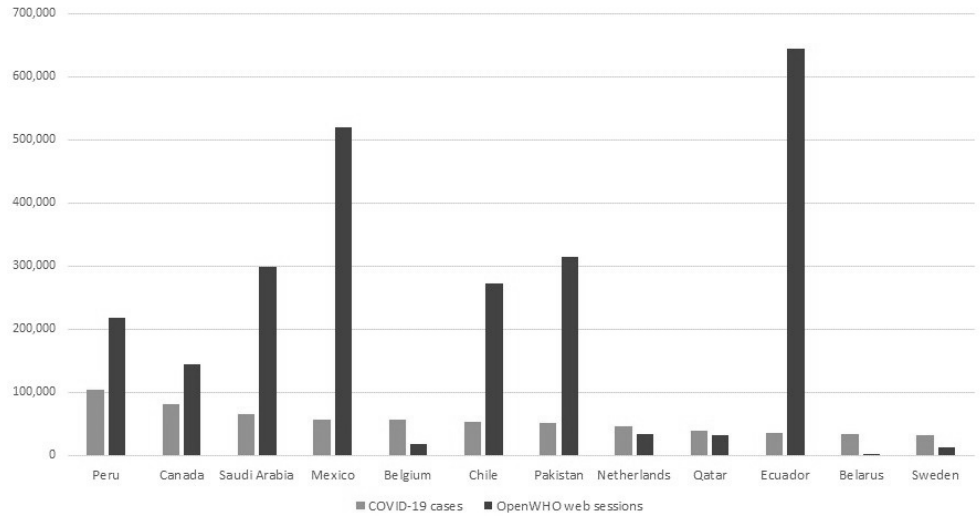

Figure 2. Web sessions in the countries listed in positions 13–24 in the highest cumulative confirmed COVID-19 cases list (11 March–22 May 2020).

3.2. Regional Use

The same data sets displayed according to WHO region also illustrate interesting geographic trends (Figure 3).

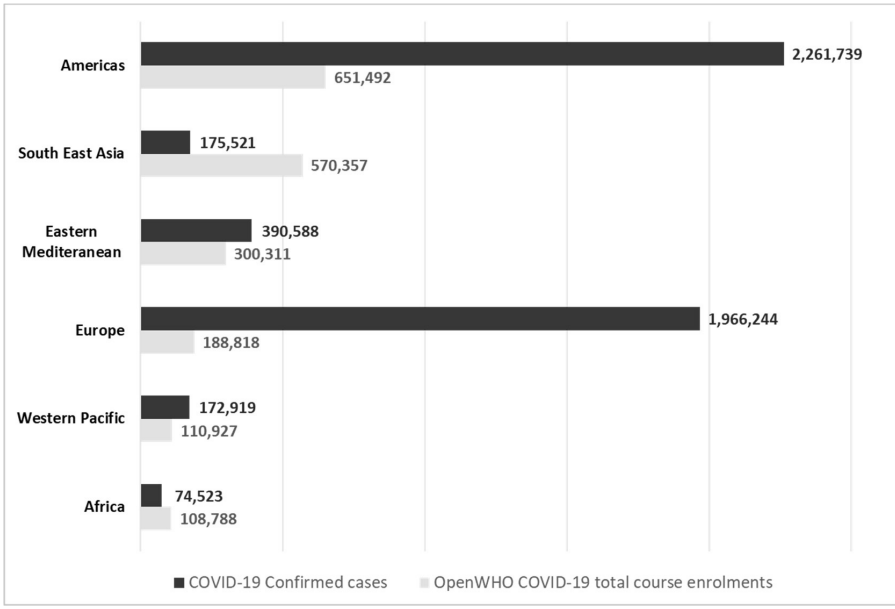

Figure 3. Confirmed COVID-19 cases and OpenWHO use (as measured by course enrolments) per WHO region as of 22 May 2020.

As per the confirmed cases count, the WHO Region of the Americas (AMRO) was the epicenter of the disease during the research period and also has the highest number of enrolments in OpenWHO courses. The COVID-19 case count in the European Region (EURO) is the second highest globally, though enrolments from this region are relatively low, reaching fourth place among the WHO regions. The South-East Asian (SEARO) and Eastern Mediterranean (EMRO) regions have a higher number of enrolments than the European region, although their case count is lower. The number of enrolments from SEARO was fueled by exponentially high use from India. Overall, for the African (AFRO), Eastern Mediterranean, South-East Asian, and Western Pacific (WPRO) regions, which are for the most part concentrated in the Global South, the levels of OpenWHO use and confirmed COVID-19 cases are close.

3.3. Course Use by the Languages of Affected Populations

WHO prioritized publishing learning materials about COVID-19 in the languages spoken in the countries most affected by the spread of the disease [24,25]. By 22 May 2020, the introductory COVID-19 course was published in 22 languages and hosted 459,412 enrolments. The first 12 courses published account for 98.88% (n = 454,289/459,412) of the total course enrolments for all 22 languages combined (Figure 4).

An examination of the use of each language version of the introductory course reveals that users from the countries most affected by the pandemic accessed this course in the national language of their country, as illustrated in Table 1. Collectively, the three most commonly used language versions in each country account for more than 90% of the total course use from that country. This is the case for all 12 countries with the highest number of confirmed COVID-19 cases, with the exception of Russia, where a larger variety of language versions of the course were used. The Indian Sign Language course was among the top language versions used in the USA and China, suggesting that there are populations in each country in need of this resource. Less surprisingly, the course also features in the top three in India. In total, this course hosted 12,561 enrolments, making it the fourth most popular language version of the introductory course.

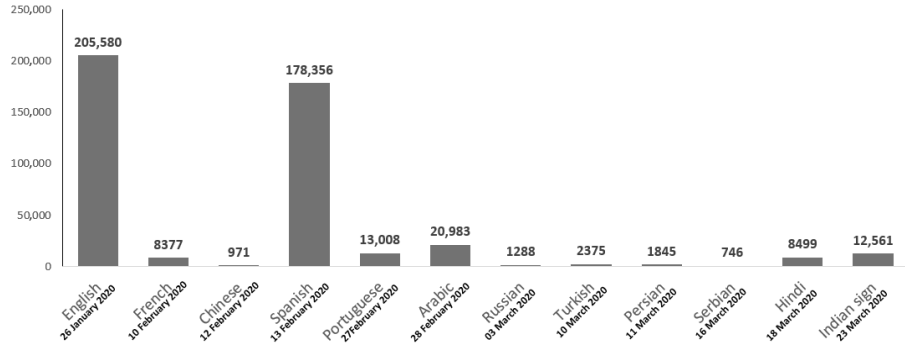

Figure 4. First 12 language versions of the introductory COVID-19 course available and enrolment numbers.

Table 1. Language versions of the introductory course used in the 12 countries with highest confirmed COVID-19 cases. Top three language versions used listed per country.

Country	Top Language Version Used, n (%)	Second Most Used Language Version, n (%)	Third Most Used Language Version, n (%)	Total Top Three Language Versions Used, n (%)
USA	English 22,693/25,070 (90.52%)	Spanish 1324 (5.28%)	Indian Sign Language 216 (0.86%)	24233 (96.66%)
Russia	English 246/584 (42.12%)	Russian 160 (27.40%)	Arabic 98 (16.78%)	504 (86.30%)
Brazil	Portuguese 4642/6178 (75.14%)	English 1149 (18.60%)	Spanish 316 (5.11%)	6107 (98.85%)
UK	English 6561/7125 (92.08%)	Arabic 119 (1.67%)	Spanish 98 (1.38%)	6778 (95.13%)
Italy	English 1214/1472 (82.47%)	Spanish 95 (6.45%)	French 59 (4.01%)	1368 (92.93%)
Spain	Spanish 6039/7870 (76.73%)	English 1680 (21.35%)	Portuguese 62 (0.79%)	7781 (98.87%)
Germany	English 1092/1560 (70.00%)	Spanish 191 (12.24%)	Arabic 124 (7.95%)	1407 (90.19%)
China	English 214/342 (62.47%)	Chinese 108 (31.58%)	Indian Sign Language 7 (2.05%)	329 (96.20%)
Turkey	Arabic 917/2275 (40.31%)	English 660 (29.01%)	Turkish 617 (27.12%)	2194 (96.44%)
France	French 892/1532 (58.22%)	English 475 (31.01%)	Arabic 51 (3.33%)	1418 (92.56%)
Iran (Islamic Republic of)	Persian 288/574 (46.69%)	English 224 (39.02%)	Arabic 28 (4.88%)	520 (90.59%)
India	English 38,043/52,577 (72.36%)	Hindi 6663 (12.67%)	Indian Sign Language/5970 (11.35%)	50,676 (96.38%)

In Brazil, France, India, Iran, Spain, the UK, and the USA, the most used language version of the introductory course was the language that is most widely spoken or an official national language in that country. English was also the most popular introductory course language in India, Germany, and Russia. The Hindi course is the second most popular course language in India. The introductory course in German was published after 22 May 2020.

Though use of the platform is in general more modest in China and Russia, Chinese and Russian are the second most popular language version in each country respectively. Arabic is among the top three language choices in France, Germany, Turkey, Russia, and the UK, pointing to a globalized audience who, regardless of where they reside, prefer to learn in their native languages.

Of the languages mentioned above, Indian Sign Language, Turkish, Hindi, and Persian were added to the platform for the first time when published as language versions of the introductory course. With regard to the Persian course, 49.84% (n = 920/1845) of enrolments were from users who were new to the platform. For the Hindi course, this number was 29.58% (n = 2514/8499), compared to 57.17% (n = 1358/2375) for the Turkish course and 15.53% (n = 1951/12,561) for the Indian Sign Language course. Of all the language versions of the introductory course, the Spanish (65.18%, n = 116,250/178,356), Turkish (57.17%, n = 1358/2375), Portuguese (51.96%, n = 6759/13,008), Persian (49.84%, n = 920/1845), and Arabic (49.52%, n = 10,390/20,983) courses had the highest proportion of new users. The average proportion of new users across all language versions of the introductory course was 52.64% (n = 241,840/459,412).

3.4. 70+ User Group

Following the outbreak of COVID-19, the OpenWHO platform experienced a significant increase in use from individuals aged 70+. When comparing the user age distribution before the pandemic and immediately after the pandemic declaration, one of the age groups that witnessed the largest change is the 70+ group. Before the outbreak, the 70+ user group consisted of 116 users accounting for only about 0.0025% (n = 112/44,449) of the platform-wide total of 86,000 users in December. By May 2020, the proportion of the 70+ age group had increased to 5.14% of the total registered users, representing about more than 76,000 of the total 1,484,163 users registered on the platform (Figure 5). Currently, the proportion of learners aged 70+ is four times greater than the 60–69 age group (1.29%) and is comparable to the number of learners in the under 20 (5.38%) and 50–59 (5.06%) age groups.

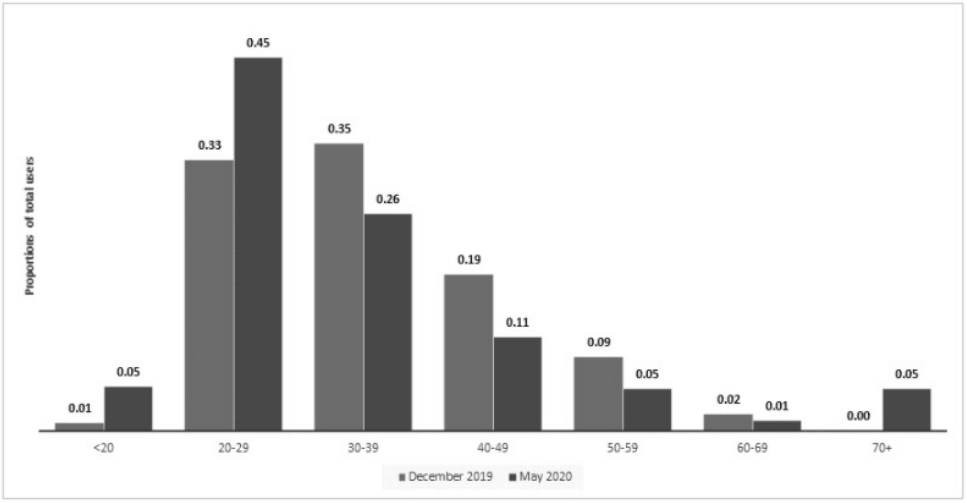

Figure 5. OpenWHO user age distribution before and post COVID-19 pandemic.

A natural explanation for this change would be the impact of COVID-19 on elderly people. Dr Hans Henri P. Kluge, WHO Regional Director for Europe, stated that, "Some of the reasons older people are greatly impacted by COVID-19 include the physiological changes associated with ageing, decreased immune function and multimorbidity which expose older adults to be more susceptible to the infection itself and make them more likely to suffer severely from COVID-19 disease and more serious complications" [26]. Research suggests that online learning can be a useful tool for informing elderly individuals familiar with computers and that solving problems faced in their lives is a popular motivation for older adults in MOOCs [27,28]. Research also discusses the specific design needs for providing barrier-free and optimization of online learning for the elderly and also focuses on active learning aspects among elderly people [29,30].

Out of the 10 courses that address the preparation and response to COVID-19 on OpenWHO, the introductory COVID-19 course, available in 22 languages and providing basic information about the novel coronavirus, exhibits the highest proportion of learners within the age group of 70+ (10.30%, n = 23,852/231,475), which is more than double the average enrolment from this age group on OpenWHO in general (5.14%). Interestingly, the other most generic course, on prevention and control, also witnessed great popularity among these older adult learners (9.21%, n = 26,644/289,371), while more technical courses, primarily aimed at frontline responders, have significantly lower than average proportions (Figure 6).

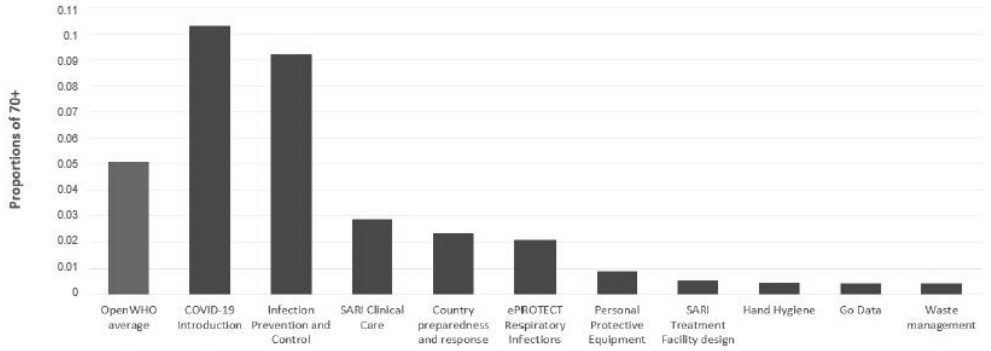

Figure 6. OpenWHO COVID-19 online course use among the 70+ age group.

For the Spanish version of the introductory course, one out of five course users is over 70 (Figure 7). In fact, the Spanish version of the course accounts for 80.99% (n = 19,317/23,852) of the total enrolments from users aged 70+ across all language versions of the introductory course, followed by the English version (13.25%, (n = 3160/23,852). Geographic analysis of the 70+ learner group (who are predominantly Spanish speaking and a majority of whom are female (62.70%, n = 11,352/18,105), reveals that 97.32% (n = 20,027/20,579) accessed the course from the WHO Region of the Americas, particularly from Ecuador (46.50%, n = 9570/20,579), Colombia (10.86%, n = 2234/20,579), Argentina (9.71%, n = 1999/20,579), Mexico (9.62%, n = 1980/20,579), and Chile (9.33%, n = 1920/20,579).

3.5. Change in Geographic Platform Use Patterns over the Course of the Pandemic

Thirteen out of the 24 countries with the highest number of COVID-19 cases between 11 March and 22 May 2020 were also in the top 24 countries in terms of OpenWHO use in the same period. Additionally, out of the 24 countries with the greatest OpenWHO use prior to the pandemic, 10 of these would go on to join the list of the 24 countries with the highest number of COVID-19 cases during the pandemic (Table 2).

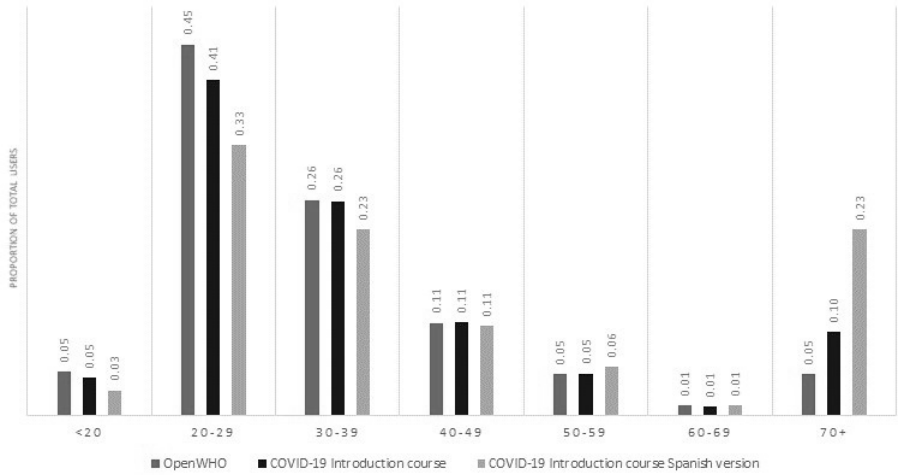

Figure 7. Age distribution of users enrolled in the COVID-19 introductory course on OpenWHO.

Table 2. Top 24 countries by OpenWHO use during the last 10 weeks of 2019 and the 10 weeks following the COVID-19 pandemic declaration.

Final 10 Weeks of 2019 (23 October–31 December 2019)	10 Weeks Following the Pandemic Declaration (11 March–22 May 2020)
1. India	1. India (0) *
2. Nigeria	2. Ecuador (-) *
3. USA	3. USA (0) *
4. Democratic Republic of the Congo	4. Mexico (-) *
5. UK	5. Bangladesh (-)
6. Portugal	6. Colombia (-)
7. Egypt	7. Argentina (-
8. Canada	8. Pakistan (+6) *
9. Saudi Arabia	9. Saudi Arabia (0) *
10. Sudan	10. Nigeria (−8)
11. Kenya	11. Chile (-) *
12. Switzerland	12. Philippines (+5)
13. South Sudan	13. Iraq (-)
14. Pakistan	14. UK (−9) *
15. France	15. Peru (-) *
16. Germany	16. Egypt (−9)
17. Philippines	17. Spain (-) *
18. Ethiopia	18. Brazil (+3) *
19. The Netherlands	19. Canada (−11) *
20. Cameroon	20. Nepal (-)
21. Brazil	21. Indonesia (-)
22. Australia	22. Italy (-) *
23. Uganda	23. Australia (−1)
24. Côte d'Ivoire	24. United Arab Emirates (-)

* Countries in the top 24 for confirmed COVID-19 cases; (-) New to the top countries list for OpenWHO use after the pandemic declaration.

It is also interesting to note the change in the geographical pattern of platform use before the pandemic and in the 10 weeks following the pandemic declaration. Half of the top 24 countries with the greatest platform use between 11 March–22 May 2020 were already established as such prior to the pandemic, while the other half joined the list during the pandemic. Three major findings can be drawn from examining this data:

(1) Before the pandemic, 10 African countries were among the top 24 countries in terms of OpenWHO use. In the 10 weeks after the pandemic was declared, the use among African countries fell and, as a result, only two countries, Nigeria and Egypt, remained in the top 24 list. In the same period, no African countries were present among the 24 countries with the highest number of confirmed COVID-19 cases.

(2) Six South American countries and three Asian countries joined the top 24 list for the first time. Four of these six South American countries were among the countries with the 13th to 24th highest number of confirmed cases during this period.

(3) Before the pandemic was declared, six European countries appeared in the top 24 countries list. Following the pandemic declaration, only Italy, Spain, and the UK appeared in the list. Of these, Spain and Italy appeared as new additions to the list. Each of these three countries was among the top countries globally in terms of confirmed cases, situated in positions 4–6.

4. Discussion

The aim of this study was to investigate the properties of users accessing OpenWHO's COVID-19 courses during the pandemic. The findings illustrate that the platform is used most in the countries with the highest transmission of the virus. There was a 54.17% (n = 13/24) overlap between the list of the 24 countries with the highest confirmed COVID-19 cases between 11 March–22 May 2020 and the 24 countries with the highest use of the OpenWHO platform in the same period.

Though the use of the platform is mixed among the WHO regions, a comparison of the COVID-19 case count in each region against the level of OpenWHO use revealed some interesting trends. Most notably, the use of OpenWHO was highest in the Region of the Americas, where the number of confirmed COVID-19 cases was also the highest. This fact, in addition to the close strong relationship between the number of confirmed COVID-19 cases and OpenWHO use in the African, Eastern Mediterranean, South-East Asian, and Western Pacific regions, supports the argument that the learning interventions offered on OpenWHO are of use to populations affected by the outbreak. The location of the latter four regions in the Global South also confirms the platform's usefulness and reach in resource-limited contexts.

In the majority of the countries most affected by the pandemic, OpenWHO users accessed materials in the languages most widely spoken in their locations. On average 52.64% (n = 241,840/459,412) of users who enrolled in the introductory course (across all language versions) were new to the platform, suggesting that a significant proportion of users arrived on the platform for the purpose of gaining essential knowledge about the pandemic. The proportion of new users enrolled in the Spanish and Turkish introductory courses was above average, highlighting the importance of providing materials in these languages to access new audiences. The high uptake of courses in countries in the Region of the Americas could be further explained by the early translation of the introductory course into Spanish as well as support in outreach through collaboration with the Pan American Health Organization (PAHO) Virtual Campus for Public Health. A similar proportion of new users can be seen in several other language versions, including Persian, Serbian, and Macedonian, which, like Turkish, are languages new to the platform.

The COVID-19 pandemic increased the proportion of users aged 70+ on the platform. The introductory course exhibited the highest proportion of 70+ users of any COVID-19 course, exceeding the platform average. The increase in platform use among users aged 70+ could be explained by the heightened impact of the disease on older adults, who are deemed high-risk.

With regard to the geographic change in OpenWHO use during the pandemic, 11 out of the 13 countries that were new entrants into the top 24 list are in the Global South. Of these, nine are low- or middle-income countries according to the World Bank. In addition, as the platform use expanded into the Spanish-speaking world, six South American countries entered the top 24 list. This reflects a significant shift in the pattern of platform use from 2019. This finding was also reflected in an analysis of data extracted from the two months after the launch of the introductory course, which found that apart from the English course, the Spanish version was overwhelmingly the most popular [31].

Prior to the pandemic, the high levels of OpenWHO use in African countries reflected the concentration of health emergencies within the continent. The change in the pattern of OpenWHO use has mirrored the way that the spread of COVID-19 has shifted the loci of outbreaks to other geographical regions. The two African countries that remain in the list of the top 24 countries for OpenWHO use are also among the three countries with the largest populations on the African continent. The countries in the top 24 list constitute 55.74% (n = 5,993,930/10,752,536) of the total use of OpenWHO during the research period.

In summary, those who require learning support most, whether due to their location at an epicenter of the pandemic or due to their age, have accessed the platform. Further research will include longitudinal comparisons of the presence of COVID-19 and the use of OpenWHO in select countries.

Limitations: The focus of this article is the first 2.5 months following the pandemic declaration. Particular attention was given to the countries with the highest confirmed COVID-19 cases. Users in some countries are unable to access the platform and, thus, their use is difficult to compare. Some materials have also been embargoed through different channels and, thus, not all countries and courses are fully comparable. It should also be noted that course enrollees' proportions are determined based on the users who disclose the relevant information during the OpenWHO registration process.

5. Conclusions

This study suggests a real-time strong relationship between the significant increase in user numbers on an established WHO online learning platform and the number of cases of COVID-19 in the 24 countries with the highest number of COVID-19 cases during the study period. It also provides evidence on the value of offering learning material in the native languages of the people at the center of emergencies. Additionally, it illustrates that even when courses are primarily intended for responders, the segment of the public most at risk, for example, the elderly in the case of COVID-19, will also access the learning content.

The evidence illustrates the need to establish formal processes and increase investment with regard to the practice of fast-tracking the development and delivery of courses during an emergency; the need to focus on accessibility issues, such as translation into the languages spoken in the epidemic or pandemic hotspots; and the need to offer learning material tailored to the people at risk, in addition to responders. While further research into all three aspects is needed, the research presented here is unique in that it analyses data collected during a pandemic and links epidemiological trends with the uptake of learning online. On a broader level, it underscores the importance of real-time training during a disease outbreak, epidemic or pandemic, with heightened focus on accessibility and the preferences of users.

Author Contributions: Study design: H.U.; Data collection, figures, data analysis: N.N., C.P., R.G.; Data interpretation, writing: H.U., G.G., R.G., M.A., N.N.; Literature search: M.A. All authors have read and agreed to the published version of the manuscript.

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PUBLICATION

IV

Online learning for mass audiences during the COVID-19 pandemic: Key considerations for real time knowledge transfer

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Online learning for mass audiences during the COVID-19 pandemic: Key considerations for real time knowledge transfer

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Abstract—This paper introduces online learning related key considerations for asynchronous health information dissemination during the COVID-19 pandemic. The findings are based on 1.5 years of real-time massive scale learning intervention during this public health emergency and on related literature reviews. Metadata analysis on World Health Organization's (WHO) open access online learning platform OpenWHO and review on health emergency learning interventions literature. The study sought to operationalize the key considerations related to the health information dissemination as an asynchronous online learning delivery. Statistics driven findings were made based on open-source learning platform OpenWHO use case and scientific literature from the similar recorded experiences. The paper presents analysis from the recent literature and couples it with the real-time pandemic learning response results. The study suggests establishing key considerations for health emergency related learning dissemination for mass audiences: Real-time learning provision in free access, low-bandwidth and offline use formats, national and local language provision, choice of format for learners and adjustment of the learning content based on adult learning principles. The key considerations of the online learning delivery in mass mode in health emergencies emerged from the study and are recommended way forward for any international learning provided in health emergencies.

Keywords— Massive open online courses, online learning, COVID-19 pandemic, World Health Organization

1 Introduction

When reports of the novel coronavirus emerged in January 2020, World Health Organization's (WHO) OpenWHO online learning platform team sprang into action, relying on its 2.5 years of prior experience in real-time learning response to health emergencies. The pandemic learning response of the WHO was channeled through transferring real-time knowledge for COVID-19 through WHO's free online learning platform OpenWHO.org.

Asynchronous, self-paced learning intervention that is not bound to time or place deemed to be the feasible option to reach to mass audiences as physical contact were halted by lockdowns, meeting and travel restrictions and closures of schools and non-essential services in many parts of the world. WHO experts helped the OpenWHO team to adapt existing WHO evidence on the novel coronavirus (later named COVID-19) and guidance on managing severe acute respiratory pathogens into learning courses [4]. Course production accelerated as the first WHO Emergency Committee meeting took place 22-23 January 2020 and, fulfilling the requirements of WHO's Emergency Response Framework, the first learning resource was put together over the next 72 hours and launched in open-source format on 26 January 2020. This took place before a Public Health Emergency of International Concern (PHEIC) was declared on 30 January 2020. Since January 2020, the OpenWHO team has transferred essential knowledge for managing the COVID-19 pandemic to frontline responders, decision-makers and the public in a mass delivery mode [5].

The primary goal of this research is to explore key enabling factors that contribute to the equitable learning experience for mass audiences. This research also aims to determine which online practices drive the reach in the global information dissemination context. In particular, the current study aims to pinpoint specific online learning strategies as evidenced in the related literature. Additionally, the documented and data driven knowledge transfer work on OpenWHO platform informs the operational side of work.

Finally, this project should be considered as a live example of how evidence-based information collected by the literature review in 2020 (Phase 1) informed practical implications and confirmed decisions employed on the OpenWHO platform (Phase 2).

2 Methods

This descriptive study is comprised of a literature review focusing on online learning in public health and online learning and COVID-19 pandemic and of a component analyzing OpenWHO user metrics on OpenWHO platform over the 15 months of pandemic response.

2.1 Research Questions

1. What are the key enabling factors, means and values for equitable and global learning information dissemination for mass audiences during the COVID-19 pandemic?
2. What online practices should be put in place to drive the reach and ensure access in the global information dissemination context?

2.2 Phase 1: Literature review: Study Design, Data Collection and Analysis

A literature review was carried out using search terms identified within three key concepts: Online learning, Public Health and COVID-19 pandemic. Key terms were searched using a free text strategy in the titles and abstracts. Databases searched included the Cochrane Database of Systematic Reviews, the Campbell Collaboration Database of Systematic Reviews, GIFT/HINARI, PubMed/MedLine, and the Wiley Online Library. Databases were searched using predefined combinations of key terms. Articles were published between 2008 – 2021. There were also separately identified four papers included from 2021.

All identified references were imported into the bibliographic management software ENDNOTE X7- with exception of the GIFT/HINARI database and the Campbell Collaboration Database of Systematic Reviews were extracted as text files. A total of 36 research papers fulfilled the inclusion criteria and were reviewed using a standardized form that included information on the period of study, location, study sample and design, research questions/aim and objectives, key findings, and conclusions.

2.3 Phase 2: OpenWHO Study Design, Data Collection and Analysis

The project employed a descriptive study design, which included analysis of the OpenWHO user data. The OpenWHO user metrics included parameters related to location, gender, language, age, and affiliation of users. Anonymized statistical datasets were obtained from the OpenWHO integrated reporting system, providing platform-wide, topical and course-specific and language version datasets (1-9). Additionally, durations of the web-sessions and learner behavior on the platform were captured in the platform data. Moreover, course users' OpenWHO activity by geographic location was captured by Google Analytics. Selected use cases from the platform data were explored in order to investigate user groups, use of languages, general metrics, etc. Overall, the data were collected from January 2020 to March 2021 with data over the 15 months of pandemic response and included data of 2 285 446 million users, 5 090 545 million course enrolments from 194 countries.

Data were analyzed using Power BI to present descriptive statistics. Several platform course survey data are referred to. Variables of interest included those describing socio-demographic information of the OpenWHO users' location, gender, language, age and affiliation as well as users´ learning behavior and motivation. We also presented data on users' learning behavior. Users´ learning behavior was captured by the duration of the web sessions, with "an active session" defined as the period when a user actively engaged with the OpenWHO platform.

Departing from the findings of literature review and informed by analysis of imperial data of OpenWHO, we summarized available evidence to inform selected key considerations for asynchronous learning dissemination during a health emergency of largest scale, the pandemic.

3 Results

3.1 Phase 1 Results: Overview of the examined literature

The 36 articles were organized into three main categories:

- COVID-19 (N=19)
- Online learning (N=15)
- Learning transfer (N=2)

Out of 36 studies retained for analysis, most were reviews and/or systematic reviews (N=11), followed by commentaries (N=9). Five papers used quantitative methods, four a mixed–method approach and quantitative methods, and three studies applied qualitative design. Most of the papers reported work conducted at the global level (N=20), seven in North America, four in Europe, three in Asia and two in Africa

Influence of COVID-19 pandemic on learning and knowledge transfer

The COVID-19 pandemic caused in-person training around the world to shut down, thus highlighting the urgent necessity for alternative approaches and channels for

education, not only for health professionals, but also for the general population. In total, five studies examined this topic [8, 10, 24-29] as well as identified a number of blogs, opinion papers, communications and one ahead-of-print publication [7, 8, 30-40]. At last, out of all studies retained for review, two of them aimed to examine learning transfer [41, 42].

The literature reported on how the current COVID-19 crisis could be seen as a *"black swan moment"* on the training of health professionals, and the role of digital learning in particular [24-26]. Selected studies discussed the role of correct, timely and accessible information during COVID-19 pandemic [24-26, 40]. Aldohyan and colleagues argued that the focus of current learning strategies should not be made on the content of materials, but on the accessibility and structure of educational materials [24]. They suggested that instructors may not necessarily face the difficulties in producing new information, as an immense amount of valuable information already exists in the literature, yet the problem arises from the fact that current knowledge is either poorly structured or inaccessible to health care professionals. In this regard, it was recommended to consider a new concept of *"knowledge brokers",* who may act as disseminators of knowledge among a certain group of health professionals (e.g. the nursing body), and thus, may facilitate knowledge translation by retrieving different types of evidence, synthesizing it in different forms, translating it by evaluation, interpreting it and then distributing it [24].

Health professionals might experience some sort of "fatigue" or "tolerance" because of repetitive exposure to MERS-CoV education and campaigns, and thus interactive activities are recommended. Hence, negative perception of knowledge transfer might be due to a pre-existing lack of trust in the media or in websites that might, to some degree, lack scientific credibility in comparison with educational programmes provided in health care centres [24, 40]. Fernandez-Diaz and colleagues argued that during health crisis situations, such as COVID-19, communication must be understandable and accessible by all types of people, regardless of their technology, language, culture or disability (physical or mental) [25]. Also, colour vision deficiency should be also taken into consideration when creating accessible web content [25]. Overall, authors called for "*web accessibility for all*", providing that digital education platforms should offer text alternatives for non-text content, especially for people with vision impairment who use screen readers [25, 26].

Chick and colleagues, examining how the educational landscape for surgical residents should be changed during the pandemic, suggested considering several innovative solutions including the flipped classroom model, online practice questions, teleconferencing in place of in-person lectures, involving residents in telemedicine clinics, procedural simulation, and the facilitated use of surgical videos Guidelines 2.1[26]. In the Journal of Educational Change Zhao and Watterson [7] argued that the pandemic has created a unique opportunity for educational changes proposed before COVID-19 but never fully recognized. They identified three big changes to the education for post COVID: (a) curriculum that is developmental, personalized, and evolving; (b) pedagogy that is student-centered, inquiry-based, authentic, and purposeful; and (c) delivery of instruction that capitalizes on the strengths of both synchronous and asynchronous learning. This echoes what we have learnt and experienced in WHO.

Recent literature shows that COVID-crisis has created a new reality, changing the way of how our life used to be conducted. This also implies that social processes are changing now and will change more in the future. In this regard, studies discussed a major shift toward online learning approaches as well as urgent necessity not only to educate and engage health care professionals, but also communities [24-27]. Thus, the social value of knowledge translation might be considered, where a social value co-creation perspective incorporating the interests of multiple actors can be used [31]. This also might contribute to the validation of knowledge transfer as different actors involved in the process of its co-creation will develop ownership. It is worth mentioning that there are aged-based and context differences on how people locate COVID-19 news and information. It was demonstrated that the WHO's social media channels were the most popular among people aged 18-40 years in India, Mexico, and Nigeria while in Egypt, Indonesia, Russia, and South Korea, search platforms were preferred [8].

Evidence suggested that peer educators, drawing on the credibility which they have among people in their social network and leveraging the power of a role model, might be an important building block of learning approach during COVID-19 [24]. Therefore, dynamics within different networks and communities of learning should be considered. Additionally, an online tool to validate health information might be considered. Finally, while there is a certain polarization of current debates on digital and traditional learning in health care education, one might argue for a more holistic standpoint trying to marry these concepts and take the best of both to meet the needs of local communities and contexts. Overall, using a divisive pluralistic approach, intended to contrast and compare digital and traditional learning might not necessarily indicate their strengths and weaknesses or how to build on them. However, newly appeared proponents and opponents of these two learning modes inadvertently clash, bringing the agenda away from collaboration and creation of a novel strategy incorporating ideas of online learning as well as a traditional learning approach.

Online learning as an enabler

Effectiveness

Learning effectiveness is presented based on twelve studies reported on effectiveness of digital learning, including all systematic reviews, which assessed online learning approaches in the areas listed below: technology-enabled knowledge translation strategies (TEKT) to increase use of research in public health [43]; digital education on chronic wound management [44]; artificial intelligence (AI), and diagnostic deep learning algorithms for medical imaging [45]; enablers, and barriers of e-learning in health sciences education [46]; cloud technology adoption in health sector[47]; digital education on clinical practice guidelines [48]; digital undergraduate education in dentistry [27]; and e-learning programmes in licensed health professionals [49]. Additionally, four quantitative, and one qualitative studies examined effectiveness of such digital activities: e-learning programme focusing on improving health care professionals' attitudes, and practices on breastfeeding [52]; e-learning course on child protection in medicine [53]; utilization of virtual worlds as a platform for collaborative meetings in health

care [50]; and a massive online open course on implementation research for learners in low- and middle-income countries [9].

We observed a high diversity of outcome measures, and period of observation applied in relation to effectiveness. For example, most studies examined changes in the knowledge level of health professionals over time, yet study design varied from a cross-sectional with a pre- and post-test assessments (i.e. testing before and after learning activity) [53] to a longitudinal approach, where knowledge retention up to six months or a one-year follow up was carried out [52]. Consequently, these inconsistencies may lead to equivocal results demonstrated by authors. It is also suggested to consider the nature of the discipline as digital learning might be more effective in certain domains of public health and medicine, while it might not be as effective in others.

Four systematic reviews demonstrated that digital learning approaches may be effective in improving the knowledge of public health professionals [43, 44, 48, 49]. In three articles, digital learning approaches were claimed to be more effective than no intervention in improving knowledge [43, 44, 48] or at least as effective as traditional learning [48]; yet one systematic review suggested that e-learning may make little or no difference in patient outcomes or health professionals' behaviours, skills or knowledge [49]. Moreover, knowledge level was also examined by two cross-sectional studies conducted in Germany, and Italy, one case study in Portugal, and one evaluation of a massive open online course (MOOC) [9, 52-54]. Authors reported an improvement of knowledge level [53, 54] as well as participants of these interventions reported utilization of the knowledge [31], and skills gained in their professional lives frequently [9]. Previous research on the effectiveness of digital learning for knowledge acquisition in health professionals confirmed that either online or blended learning had a more consistent positive effect than no intervention or traditional learning [17-20]. However, findings indicated that instructional strategies had an impact on the provision of effective learning regardless of the mode of delivery as there is no 'one-size-fits-all' approach to optimizing outcome measures [17-21].

Maier and colleagues, when assessing effectiveness of an online course, described how attitudes, and practices regarding the protection, promotion, and support of breastfeeding were higher immediately after training, but decreased over time [52]. The evidence suggests that to maintain transfer of learning after training and avoid skill decay learners should be able to use what they learned, receive timely constructive feedback, and refresh their learning through job aids or retraining [56, 57]. Research on training transfer indicates that factors such as work environment (i.e., supervisor or peer support), trainee characteristics (i.e., motivation and self-efficacy), and training design can affect retention and transfer of acquired knowledge and skills [11-16]. Salas and colleagues contend that retention of learned material and assessment of transfer should be targeted for training evaluation using rigorous methods for collecting such data [56, 57].

Many authors argued that there is a need to establish generally accepted digital standards of education to provide effective learning and consider collecting data on the cost-effectiveness or cost-benefit of digital learning approaches. Previous studies comparing cost-effectiveness of digital and traditional learning indicated that both online and blended learning were found to be more cost-effective than traditional instruction;

nonetheless, the cost-benefit of these modes of delivery could not be determined without more rigorous data [22, 23].

Evidence from several systematic reviews have shown that these approaches are more effective in the knowledge level of public health professionals if compared to no intervention or are at least as effective as traditional learning in improving learners' outcomes. These findings might be especially important in situations, such as a pandemic, when the ability to employ traditional or blended learning approaches is limited.

Accessibility, availability and feasibility

We reviewed nine articles which examined different aspects of accessibility, availability, and feasibility of digital learning, including: costs (time restraints, faculty, and transport costs), needed participants' baseline computer skills (digital literacy), equipment, personalization, student-centred learning, interactivity, ease of use, continuity and digital inclusion [9, 27, 36, 44, 46, 47, 50, 54, 55].

Digital approaches were more intuitive, interactive and facilitated continuous participation of students through their own dynamics [27] or even to lifelong learning [46]. Thus, one study indicated that e-learning could meet lifelong education needs, as well as widening participation in achieving desired learners' outcomes in practice, as e-learning approaches were often context-specific [46]. Furthermore, it was argued that digital learning allowed students to work at their own pace, and thus, was by nature more flexible, self-directive and inclusive [27, 44, 46, 54]. Participants were able to revisit learning materials at any time, and from anywhere they liked, using multiple tools promoting interactions with their colleagues. Moreover, digital learning might be an alternative avenue to educate the adult population without having to make them choose between their professional and family lives or going back to university to improve their knowledge and self-confidence [27, 44, 46, 54].

Zitzmann and colleagues, in the systematic review on digital learning in dentistry, suggested that students today, particularly the millennials, expect learning materials to be instantly and always available, including their grades, course schedules, and other information to be generated automatically 24/7 [27]. In this regard, not only e-learning should be considered as an alternative way to meet the current needs of students and health professionals, but e-teaching should also be taken into account as it also requires a certain shift of pre-existing pedagogical paradigm, and a change of mindset of the faculty (trainers) as well to enable theoretical, and practical knowledge transfer [36, 54].

Data demonstrated that some people might feel more comfortable, and less nervous as online approaches created a learning environment in which immediate digital evaluation and feedback were provided [27, 50].This together with self-evaluation and self-correction might improve students' knowledge and enhance instructor evaluation [27, 50]. Taylor and colleagues illustrated how the utilization of virtual worlds for meetings could help people who experience anxiety when meeting face-to-face to gain confidence and be more vocal [50]. Still, personal instruction and feedback from faculty (instructors) cannot be replaced by digital feedback only, especially when supervising

students (trainees) during patient treatment in clinical courses which is why the role model function of faculty (instructors) is important [27].

Three studies discussed in detail which elements of digital learning should be improved and how [27, 47, 51]. Sadeghi and colleagues reported on how the adoption of cloud technology may facilitate digital learning, as it may be perceived of easier to use, of higher security and confidentiality, which can be easily explained by the growth in the utilizations of tablets and smartphones [47]. Furthermore, Zitzmann and colleagues suggested that replacing scripts with pictograms in educational videos for undergraduate dentistry students may facilitate a language-independent application in several countries and thus, may save time [27]. Nugroho and colleagues described a new method for selecting elements in order to improve current e-learning strategies using the Difficulty-Usefulness Pyramid with Weighting (DUP-We), namely: learning design, handout book, links to resources, discussion, chat, assignment, feedback, quiz and survey. The authors found that to improve e-learning in health, the assignment was the first element to be prioritized, followed by: quiz, feedback, discussion, link to resources, books, surveys, learning design, handouts, and chat. It was also recommended to handle the five elements listed below first: assessment, quiz, feedback, discussion and link to resources [51].

Seven studies reported on how digital learning saved costs, including: time of both trainers and trainees, transport costs (which may depend on distance to learning centres), number of faculty involved, and needed spaces [9, 27, 44, 50, 54, 55]. These approaches required a certain baseline level of computer skills, equipment, and access to the Internet, which might serve as a barrier for participants from low- and middle-income countries or certain populations (e.g., refugees or people with vision problems) [9, 25, 55]. Participants' baseline computer skills (digital literacy) were a significant factor which either could impede or facilitate adoption of digital learning [47, 50, 55]. For example, in Kenya, it was shown that access to blended learning allowed participants to build on their technical capacity, which then contributed to the professional health workforce in Dadaab, as obtaining computer skills enabled participants to not only access education but also job markets [55].

Whereas the feasibility, accessibility, and other aspects of digital learning may contribute to effective learning, it is important to consider the advantages and barriers of digital learning in conjunction to determine desired results, in particular knowledge transfer and knowledge translation. It was gathered from the reviewed papers that there are several enablers and barriers of digital learning. Table 2 illustrates the list of enablers and barriers of digital learning approach.

In conclusion, online leaning breaks paradigms, brings innovation and new perceptions in pedagogy, and by doing so facilitates an alternative process of teaching and learning. For example, Carapeto and colleagues shared their successful experience of the nutrition and health course implementation and reported how this approach created new meaning in the relationship between teacher and student, especially in the teaching and learning process as the pedagogical dynamics were coordinated with the new technologies [54]. Overall, digital learning offers a suitable alternative to deliver knowledge to health care professionals who may not be able to access them otherwise, due to workload, distance from learning centres (transport), and other costs [44]. Finally, we argue

that the positive effects of digital learning are diverse, and they may involve different spheres of life and work of learners. Learners' gains might involve direct short-term results and learners´ needs could be addressed (e.g. improved level of knowledge). Further, as literature has shown, it may include beneficiary second-hand effects and meet broader long-term learners´ needs (e.g. adoption of computer skills, which may assist in job search or promotion). Therefore, a more nuanced understanding of digital approaches and their impact on learner's lives is needed.

Table 1. Enablers and barriers of digital learning approach

Enablers	Barriers
Costs saving [9, 27, 44, 50, 54, 55]; Intuitive; Perceived ease of use for people with higher digital literacy [27, 46, 50, 51]; Flexibility; Materials could be accessed 24/7, helpful for revisions and exams [27, 46]; Adaptivity; Providing students more choices in terms of the place and pace, adjusted to learners´ rhythm (self-directive, self-regulation, autonomy, and accountability) of learning experiences [46]; Continuous participation [27] or lifelong learning [46]; Inclusive; Meeting persistent needs of different populations (working adults, [27, 44, 46, 54] people who are nervous when meeting face-to-face, [50] millennials [27]); Learners at the center of pedagogy [46]; Contextualized [46]; Reflective thinking, self-confidence and satisfaction [46].	Digital literacy and technical capacity [47, 50, 55]; Internet access and quality of Internet connection and other technical difficulties [9, 46, 55]; Time and resources needed to train people (learners and instructors) [9, 55]; Potential isolation; No real-life relationships with peers and tutors. Lack of non-verbal communication; Poor support [46, 50]; Language barriers [46]; Vision problems of learners [25]; Poor integration of e-learning in practice, existing academic curriculum and professional education [46]; Self-discipline and technology-phobia [46].

3.2 Phase 2 Results: Informed by OpenWHO data

OpenWHO provides easy and open access to knowledge for frontline responders and the general public to fight the COVID-19 pandemic. The platform was designed with the global pandemic as the planning proxy. It has contributed to knowledge transfer for health emergency events since 2017 to prevent avoidable death, disease, disability and damage to societies and economies. The pandemic learning response started in January 2020, soon the unknown pathogen investigation and response was mounted at the WHO and in the member states.

Influence of COVID-19 pandemic to online learning on OpenWHO

As the COVID-19 pandemic surged, new learners joined the OpenWHO platform in a heavy upward surge. Total enrolments increased from 160 000 in January 2020 to 5.8 million in October 2021. OpenWHO published 38 COVID-19 courses covering a variety of topics from vaccination, infection prevention and control to risk assessment for mass gatherings and treatment facility design among other topics. Courses are updated as new guidance and tools become available. The courses are available in 58 languages and counting, including the 15 most-spoken languages of the world and 27 languages selected to reach vulnerable populations who may lack access to trusted information about the pandemic. Forty-two of the languages spoken in the 46 least developed

countries are featured in the platform. The steep scale-up of online platform use of self-paced courses made available during the COVID-19 made OpenWHO become WHO's largest online learning platform by enrolments. 82.51 % of all enrolments were on COVID-19 topics, making the pandemic the reason for the platform enrolment growth.

Online learning as experienced on OpenWHO

Effectiveness

When examining the effectiveness of the knowledge transfer through online learning, OpenWHO has experienced not only massive increase in the enrolments, but also a steady increase in i) attendance to the courses, ii) course completion rates and iii) improved levels of knowledge retained. Nonetheless, it was observed that the attendance rate is the most prominent during the first four weeks following each course launch where after it gradually decreased over time.

First, as of March 2021 OpenWHO data, a total 2 285 446 unique learners had joined the platform, contributing to a total of 5 090 545 enrolments. This calculates into average 2 courses attended by each learner. 52% of the learners only took one course. On the other hand, there were 75 105 learners who had completed more than 10 courses on the platform (Figure 1). A badge system recognizing the achievements was launched on the platform to generate badges for the users.

No. of courses	No. of users	% of GT
1	1012976	52%
2	434854	22%
3	200203	10%
4	98895	5%
5	55796	3%
6	33428	2%
7	21525	1%
8	15239	1%
9	11090	1%
10+	75105	4%

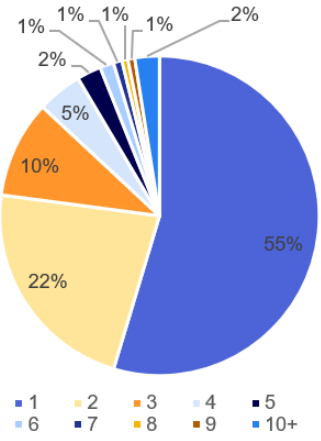

Fig. 1. Number of courses completed by users on OpenWHO.

Second, the platform has issued more than 2.8 million certificates. Half of them were for Completion of Participation (CoP), a certificate that is generated when 80% of the learning content of the course is completed. Half of the certificates were for the Record of Achievement (RoA) that testifies the learning content and the end of course assessments have both been completed at least at the level of 80%.

Average completion rate on OpenWHO increased from 39.19% before the pandemic time (December 2019) to 54.19% in March 2021. Some courses hit very high

completion rates, such as the health worker vaccine course in Spanish, 89 % and Ebola GO pre-deployment course, 94%.

Lastly, following the outcome measures such as the knowledge increase and learning retention, recent evidence from the health worker vaccine course pre- and post- test results [63] informed on the increased knowledge retained from before the course to the course completion stage.

Exploring the effectiveness of other aspects than the learning outcomes and retention, OpenWHO did not have prior precedent to measure and report on cost effectiveness or contribute to the cost-benefit analysis. Further, OpenWHO has not been part of any certification system and this also will be explored in the future, along with the WHO corporate directions in the learning domain. Also, the impact of the factors from the environment [11-16] has not been largely explored on OpenWHO.

Accessibility, availability, feasibility

OpenWHO generated data from the platform use case to inform the WHO as the learning provider on the aspects for equitable and enabling knowledge transfer and information dissemination. In terms of access and reach, the platform proved to be accessible everywhere in the world. The platform has been used in all 194 member states as per the recent World Health Assembly 2021 map (Figure 2).

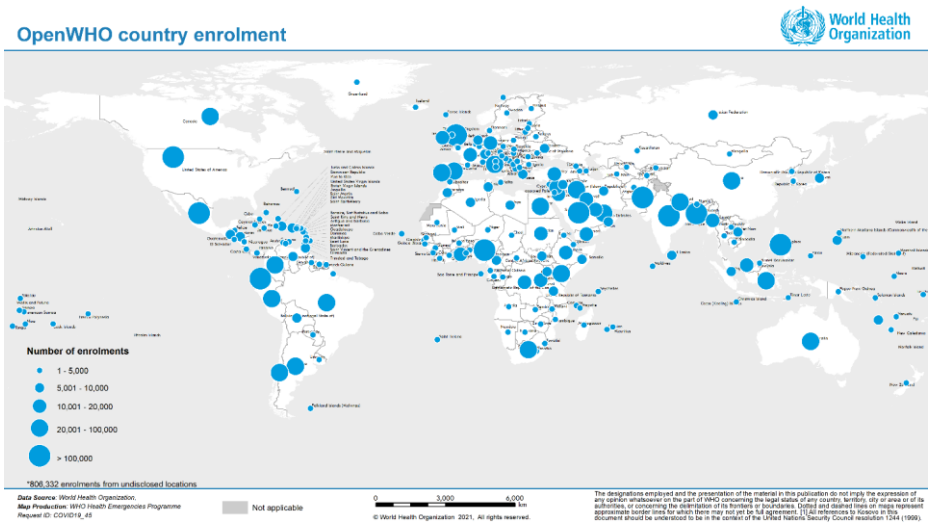

Fig. 2. OpenWHO country enrolment by countries as of March 2021 global data.

Low- and middle-income access has been shifting over the pandemic when comparing December 2019 and March 2021 data. Enrolments by users from low-income countries (LIC) dropped from 14.2% to 3.4%, a similar trend was seen for high-income countries (HIC) dropping from 45.9% to 25.9%, contrary to a spike seen for middle-

income countries (MIC) users, jumping from 40.2% to 70.7% of total enrolments. Factors attributing to this phenomenon are yet to be explored.

To investigate the learner perceived accessibility issues, a survey conducted in March 2021 captured some information on the enabling factors in general. A total of 365 respondents completed the survey. The item on challenges that hinder accessing knowledge, training, or education give an indication of the likely barriers to learning. The responses suggested that top five challenges in accessing the learning were time (48%), cost (45%), digital access (24%), not knowing where to access reliable source of learning materials (24%), and language (19%). Female respondents were twice as likely to choose time and cost compared to male respondents. The enabling factors were OpenWHO platform being easily accessible, gratis, informative, simple, and suitable for everyone.

A survey on health worker vaccine courses also asked about the barriers to attend the course. While 56% indicated no barriers, those who had experienced barriers listed them being internet connection issues, platform or IT related, difficulty in navigating the pages, time constraint, and language barrier. Out of the most indicated barriers, the internet connectivity was an issue for the learners from Global South despite OpenWHO requirement is the low bandwidth adjusted delivery. This still needs more investment and effort in terms of reducing the access issues caused by the internet and browsing.

Feasibility

On the availability and feasibility side, the aspects of material flexibility, ease of use and intuitiveness were explored. Due to the nature of the emergency learning courses, the materials needed to be developed fast in an event of any outbreak or health emergency. The OpenWHO platform emergency learning courses consisted of three simple elements video, texts and quiz. The selection of these material formats was informed by the accessibility issues as well as the necessity to regularly revise and update parts or entire course modules. The simple formats not only worked for the learners in the low-bandwidth settings but also for the course producers who could perform the globally dispersed production independently. As a result, live courses could be revised without any downtime for the learners.

As observed in other online learning preference [51], the similar formats were offered on OpenWHO. A survey on learner preference conducted for the COVID-19 vaccination courses in March 2021, indicated that video was the most preferred format (51.4%), followed by slides (45.9%). The least preferred format was collaborative spaces (12%).

Most of the courses were delivered via instructional videos on OpenWHO. This was consistent with previous research and findings from the literature review. Hébert and colleagues concluded that videos might serve as an effective and appreciated knowledge transfer and training tool for health professionals, with four key aspects being identified through qualitative data analysis: 1) transmitting information in a narrative form, 2) choosing good communicators, 3) creating a visual instrument that

reinforces the message, and 4) adapting the message to the local context that reinforces the message, and 4) adapting the message to the local context [41].

Based on data on accessibility, availability and feasibility aspects in terms of languages, the workflow was to produce and publish any course in the fastest possible mode in English. The sooner the English version was produced, the translation work into other key languages from the outbreak response angle was considered and initiated. UN languages were leading as top languages on the platform: English, Spanish, French, Portuguese and Arabic followed by Indian sign language, Hindi, Indonesian. Russian and Italian (Figure 3).

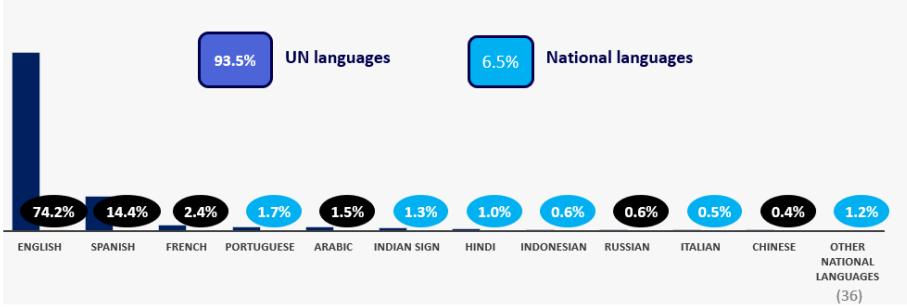

Fig. 3. Percentage of use of languages on OpenWHO.

While the UN languages counted for 93.5 % of use and all other 36 languages for 6.5 %, it was imperative to ensure accurate information reached the frontline and public in the most vulnerable settings. Impact of language on learning outcomes is documented not only in the literature, but also in the OpenWHO surveys. In March 2021 alone, OpenWHO translated nearly 1 million words. OpenWHO continued to crowdsource and work with regions, countries and volunteers to produce courses in local languages. The language offerings currently include 14 African languages.

Targeted translation into underserviced languages was done to ensure people everywhere could access life-saving knowledge in the languages they understand. A total of 26 national language courses for low- and middle-income countries (LMICs) were translated and published during 2020-2021 so that the most disadvantaged and at-risk communities could access lifesaving information to protect themselves and their loved ones from COVID-19.

OpenWHO also adjusted the formats to suit all users including the learners with special needs. OpenWHO served people with disabilities, such as the deaf community for which the courses were offered using a sign language resource, produced an Indian sign language, but used vastly around the world by 55 000 learners, with top countries India, Bangladesh, Pakistan, Saudi Arabia and Iraq.

OpenWHO and learning equity

The user group 70+ years was not represented before the pandemic, but it increased to 4.59% of learners during the pandemic. The age group less than 20 years grew from

1.26% to 9.77% representing the biggest increase and change from before the pandemic.

The COVID-19 pandemic has increasingly brought more women to learn on the OpenWHO.org platform. Platform average showed the number of women participants grew from 40.14% before the pandemic to slightly more than 50.63% currently. Whereas prior the pandemic, 70-80% of learners in courses were men, during the pandemic the learner enrolment was almost equal between women and men with some courses like the Infection Prevention and Control being led by female learners. Women had lower representation (43.10%) on non-COVID-19 courses suggesting the pandemic has equalized attendance to online learning.

Students as learners represent 38.30% of the enrolments, totaling 1.9 million enrolments. Health professionals are the second largest group enrolled on COVID-19 courses accounting for 23.70% of total enrolments. In the health worker vaccine course, the health-related affiliations were much more common counting to 67.30%.

With regards to the motivation for completing the courses, OpenWHO surveys indicated career and educational purposes being at the forefront. These were the cases of health worker vaccine courses, for which the most frequent reason (35.3%) was career, followed by certification (11.4%), education (11.2%) and mandated learning (3.1%). For Ebola e-Protect, the reasons for having attended the course were compulsory requirements (33.4%), increased knowledge about the disease (30.2%), protecting oneself from the disease (25.7%) and strengthening the future employment or assignment qualifications (10.3%).

4 Discussion

The digital transformation of WHO's technical guidance and evidence into online learning formats was in a high demand. The speed of production of learning content and scalability of OpenWHO platform itself responded to the pandemic learning need from all over the world [59]. The dynamic learning environment created lead to and facilitated a worldwide frontline response to the pandemic, worked for the purpose it was developed in a real time test. This was the first time in WHO's history that the organization was able to launch fast, high-quality, accessible learning on a massive scale to manage a health threat. While the platform served front-line responders in previous outbreaks from Ebola to plague, 2020 marked its first pandemic test. The platform has successfully delivered learning responses since January 2020. OpenWHO built on the collaborative systems already in place to quickly and dramatically scale up course production for the pandemic, making life-saving information from WHO experts available online at a time when lockdowns and social distancing limited our ability to be physically present to learn. The platform was adjusted for low-bandwidth, massive scale, easy to produce and multi-device formats to use and thus works for greater global reach.

OpenWHO is grounded in the principles of open access and equity, courses are free, self-paced, accessible in low-bandwidth and offline formats and adjusted to multi-device use. The foundational principle lays on removing all possible barriers for learners

to join. Information and learning material provision is adjusted to mass dissemination modes and the asynchronous learning format offers the materials accessible at any time.

The learning content relies on the WHO's evidence and science, norms and standards and are frequently updated to implement the changes occurring to the technical guidance documents to be revised on learning content.

Reliable and up-to-date information is essential to the pandemic response and therefore regularly updated online content is needed as the new scientific and technical guidance becomes available. For example, in December 2020, the platform expedited the production of two COVID-19 vaccination courses – one for training health workers and other on national deployment and vaccination planning – to provide local, national and global stakeholders with critical information ahead of vaccination rollouts. Meanwhile, OpenWHO's introductory course on COVID-19, published in January 2020, has been updated 13 times to reflect the latest evidence and has more than one million enrolments. The platform continues to add around 2000 – 3800 new learner enrolments a day making learning content available to people all over the world.

Pedagogical approaches used for OpenWHO courses were aligned with existing research on digital learning to enhance knowledge transfer. As indicated in the review of literature, digital learning approaches were found to be more effective to improve knowledge level of public health professionals [17-20, 43, 44, 48, 49]. In addition, several studies called for a need to develop digital learning standards to provide effective learning. Accordingly, the design and development of courses on OpenWHO followed evidence-based learning design standards. These include learning design based on inclusive pedagogy, equity, feasibility, and accessibility with regard to age, disabilities, and technical limitations such as low-bandwidth internet connection [27, 44, 46, 54].

Per review of literature, lack of access to credible and up-to-date information can be a barrier in digital learning for health professionals [24]. Having access to timely and accessible information during a global pandemic should be primary considerations in design and development of digital learning [24-26, 40]. This was closely observed in OpenWHO by ensure evidence-based and up-to-date learning material are provided to health workers and to any interested learners. While OpenWHO performs as a "knowledge broker" to disseminate WHO's evidence-based information, next steps would need to be taken by learners and stakeholders to maximize knowledge multiplication, localization and learning transfer also outside the platform premise.

The accessibility, availability, and feasibility of digital learning was explored based on literature provided enabling aspects such as cost saving, ease of use and digital inclusion [9, 27, 36, 44, 46, 47, 50, 54, 55]. Unlimited access, self-directive learning experience and intuitive use of materials were important for digital inclusion as well as adaptivity for different populations such as working adults [27, 44, 46, 54]. While some of the online learning aspects, such as the interactivity, are not a stronghold on OpenWHO, they were knowingly not utilized to ensure the widest possible accessibility.

OpenWHO helped to enhance health literacy as part of the global effort to fight the COVID-19 pandemic and this could be witnessed from the enrolments by different less represented age groups prior to the pandemic. Older people were more vulnerable to the COVID-19 disease and had actively sought life-saving information.

The barriers were found varying from digital literacy, to language and technical capacity [47, 50, 55] to internet access and quality of Internet connection and other technical difficulties [9, 46, 55]. Vision problems of learners are also listed [25] and being addressed on OpenWHO by providing audio and all downloadable versions.

OpenWHO.org was designed with equity, access, and quality in mind. First, the cost barriers were removed by offering free courses. Next, considering the digital divide, the platform offered low-bandwidth and offline versions with the OpenWHO application. The accessibility and uptake were increased by offering learning in an ever-growing number of languages. Informed decisions were made to provide a multiple format such audio, video, readable transcripts, and resource handouts. This is aligned with universal design for learning (UDL), in which the learner has the option to use the format that works for them. Quality was ensured by applying adult learning science to the design and delivery of courses using content from evidence-based WHO guidance approved by WHO experts. The key elements for reaching the impact through the online learning interventions in a health emergency are shown in Figure 4.

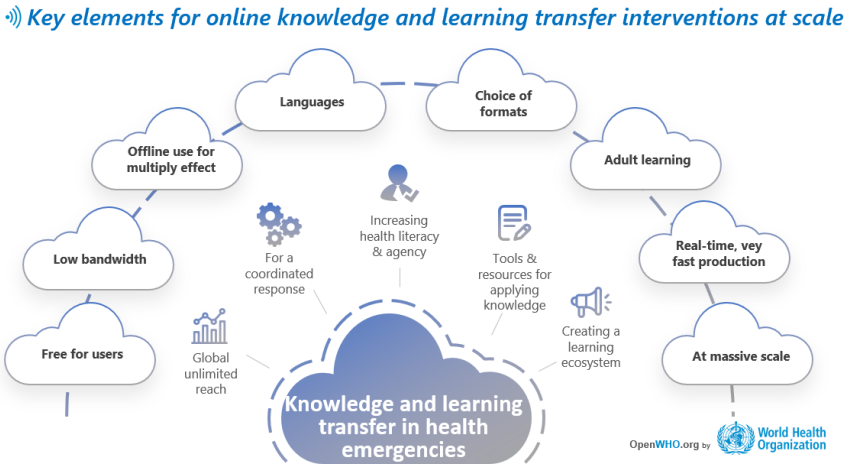

Fig. 4. Key elements for online knowledge and learning transfer at scale during health emergencies

Aligned with research in the review of literature, WHO ensured that all learning materials on OpenWHO were accessible by all learners who enrolled in the courses regardless of their technology and language by capitalizing on strengths of asynchronous learning [2, 5]. In addition, employing best practices in line with adult learning principles and learning science during content creation, and providing easy-to-understand content led to an increase of enrolment on OpenWHO by both health professionals and general public [24-27].

OpenWHO was designed to allow a small team to develop and launch courses within a short period of time; the content could be updated by the same team as new knowledge evolved as is the reality during a pandemic. The technology used for the platform also allowed massive scale up.

This paper illustrates how evidence-based knowledge may inform the practice of real-time knowledge transfer in the emergency context.

5 Conclusions

The COVID-19 online learning response has shown to be important action to protect one's and one another's' health in a pandemic. Access to updated evidence-based information is an essential need for all populations affected by a health emergency. Hence, barriers to accessing learning must be proactively and knowingly eliminated.

Latest during the COVID-19 pandemic the real-time learning has become a core element of a response to a health emergency. COVID-19 requires continued innovation and focus on equitable learning. It calls for harnessing new technology, scaling up course production and ensuring that formats, dissemination channels and languages suit the learners.

As online learning environments continue to respond to remote and self-paced learning needs, parallel demands are there to move from knowledge change to wider behavior change, from asynchronous to synchronous learning formats when feasible and necessary for the desired learning outcomes, allow moderated and interactive formats to complement the self-paced online learning, and further, to allow country-originated and localized materials to be curated to local needs.

Overall, equity must be the underlying principle and organizing criteria for all the work in public health including in learning. Without equity in access to knowledge and education, there can be no access to health and better health outcomes, and this is the case when protecting individuals and populations in public health emergencies.

Online learning interventions can contribute to globally equitable and available reach, keep the response coordinated, increase health literacy among the populations and provide agency to act. Further, the sound and solid learning base provides tools for learners to apply the knowledge in their contexts. As a major outcome, the rightly focused and disseminated knowledge and learning interventions foster and support the creation of learning ecosystems appropriated for the topic, place, and time.

6 Limitations and future work

Limitations of the review laminations: The literature review had potential limitations. One such limitation was the search period of studies, i.e., selecting research studies within 2019 and 2020. The rationale for this was to focus on OpenWHO initiative and any emerging studies as a result of the global pandemic. Standard review processes were followed; however, they were time restricted, thereby reducing their thoroughness.

Limitations of the OpenWHO data: The descriptive nature of OpenWHO data did not allow us to determine causal relationships. Additionally, we used both platform overall statistics and self-reported data, the latter risking to result in some response bias.

We also acknowledge the limitations of the non-randomized online data, which may result in some bias.

Future research: To truly harness the power of online learning beyond COVID-19 we need to address the question on how to go beyond knowledge transfer and build online learning with larger emphasis on skills delivery against set competencies. Evaluating the efficacy and impact of online learning will be the most critical question for anyone involved in learning across the health response and international systems in the pandemic response. Financial attributions related to the online learning, the impact of the environmental factors, as well as the use of online learning in low-income countries calls for more specific research, both within the OpenWHO context but also beyond.

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