Journal of International Agricultural and Extension Education

Volume 29
Issue 1 *Special COVID Issue*

Article 5

1-31-2022

Virtual Training for Managing Emerging Zoonotic Diseases including COVID-19

Ramjee P. Ghimire
Michigan State University, ghimirer@msu.edu

Karim M. Maredia
Michigan State University, kmaredia@msu.edu

Melinda J. Wilkins
Michigan State University, wilkinsm@msu.edu

Recommended Citation

Ghimire, R. P., Maredia, K. M., & Wilkins, M. J. (2022). Virtual Training for Managing Emerging Zoonotic Diseases including COVID-19. *Journal of International Agricultural and Extension Education, 29*(1), 57-75. https://doi.org/10.4148/2831-5960.1019

Virtual Training for Managing Emerging Zoonotic Diseases including COVID-19

Abstract

The burden of zoonotic diseases is an important global issue affecting human and animal health, food value chains, international trade, and the environment. Two-thirds of the infectious diseases affecting human health are of animal origin. Information and knowledge of zoonotic diseases and associated effects is critical for managing these diseases. The World TAP at Michigan State University offered an online course in zoonotic diseases in March 2021, which a diverse group of 42 participants from 15 countries in Africa, Asia, Middle East, and Americas attended. Grounded on Experiential Leaning Theory this paper discusses the conceptualization, design, implementation, outcomes of, and lessons-learned from this course. Key contents of this comprehensive course included epidemiology of zoonotic diseases, zoonoses of wildlife origin, utilizing a One Health approach to managing zoonoses, and roles of regional/ international organizations in strengthening zoonotic disease management capacities, and the lessons-learned from the pandemic on diagnosis, prevention, and prediction of zoonotic diseases. The paired t-test results using pre- and post-course survey data showed significant increases in the participants' level of knowledge on zoonoses post-course. in comparison to their pre-course knowledge. During the interactive discussion, participants stressed the need for continuing information sharing, and networking. For future offerings, the participants suggested adding impacts of zoonoses on international trade, and effect of climate change on zoonoses., and increasing collaborations between national, regional, and international organizations working on zoonoses. With the success of the first offering, MSU will continue to offer this course in the future, may be in a hybrid mode.

Keywords

zoonotic diseases, training, capacity building, online course, experiential learning cycle

Funding Source

This course was possible because of the enthusiastic participants from 13 countries and expert speakers from MSU and various international organizations. They are greatly appreciated for their participation in and contribution to the course. The CANR and CVM leaderships, Dr. Kelly Millenbah and Dr. Srinand Sreevatsan, respectively and their teams, encouraged and supported to organize this course to whom we are greatly thankful to.

Virtual Training for Managing Emerging Zoonotic Diseases Including COVID-19

Ramjee P. Ghimire, Michigan State University
Karim M. Maredia, Michigan State University
Melinda J. Wilkins, Michigan State University

Abstract

The burden of zoonotic diseases is an important global issue affecting human and animal health, food value chains, international trade, and the environment. Two-thirds of the infectious diseases affecting human health are of animal origin. Information and knowledge of zoonotic diseases and associated effects is critical for managing these diseases. The World TAP at Michigan State University offered an online course in zoonotic diseases in March 2021, which a diverse group of 42 participants from 15 countries in Africa, Asia, Middle East, and Americas attended. Grounded on Experiential Leaning Theory this paper discusses the conceptualization, design, implementation, outcomes of, and lessons-learned from this course. Key contents of this comprehensive course included epidemiology of zoonotic diseases, zoonoses of wildlife origin, utilizing a One Health approach to managing zoonoses, and roles of regional/international organizations in strengthening zoonotic disease management capacities, and the lessons-learned from the pandemic on diagnosis, prevention, and prediction of zoonotic diseases. The paired t-test results using pre- and post-course survey data showed significant increases in the participants' level of knowledge on zoonoses post-course. in comparison to their pre-course knowledge. During the interactive discussion, participants stressed the need for continuing information sharing, and networking. For future offerings, the participants suggested adding impacts of zoonoses on international trade, and effect of climate change on zoonoses., and increasing collaborations between national, regional, and international organizations working on zoonoses. With the success of the first offering, MSU will continue to offer this course in the future, may be in a hybrid mode.

Keywords: zoonotic diseases, training, capacity building, online course, experiential learning cycle

Acknowledgement: This course was possible because of the enthusiastic participants from 13 countries and expert speakers from MSU and various international organizations. They are greatly appreciated for their participation in and contribution to the course. The CANR and CVM leaderships, Dr. Kelly Millenbah and Dr. Srinand Sreevatsan, respectively and their teams, encouraged and supported to organize this course to whom we are greatly thankful.

Introduction and Importance of Zoonotic Diseases

Zoonotic diseases, also called zoonoses, are infectious diseases transmitted between animals to humans or from humans to animals. Globally one billion cases of illness and millions of deaths are associated with zoonoses annually and about 60% of emerging infectious diseases that are reported are zoonoses (WHO, 2021). Over 30 new pathogens affecting human health have been detected in the last three decades, 75% of which have originated from animals (Jones et al., 2008).

The imminent risks of zoonotic diseases are further substantiated by the fact that the animal-human nexus is getting stronger and more important than ever. Symbiotic relationships between human and animal systems that have existed for time immemorial are critical for sustaining global ecosystems. Consumption of animal-sourced food and the practice of owning pet animals, especially in developing countries are on the rise. Regional and international trade of livestock and livestock products is also rising. These trends are creating several public health challenges, specifically related to zoonoses. COVID-19 (SARS-CoV-2) is a current example of an emergent zoonotic pandemic. A deeper understanding of zoonotic diseases, their dynamics, and interventions to prevent and manage these diseases has become more critical than ever. Professionals working in animal health and public health as well as allied sectors need to be informed, educated, and empowered so that they can inform and educate their clientele to prevent and manage the spread of zoonoses and minimize the damage from these diseases.

Zoonotic diseases are global issues and widely discussed. According to Kilpatrick and Randolph (2012) many vector-borne pathogens have appeared in new regions, where they were not reported previously, for example, West Nile virus in the United States and Chikungunya virus in Madagascar. They stressed pathogens with zoonotic attributes thus transmitted are emerging in new regions primarily because of pathogen movement due to trade and travel, whereas local emergence is driven by a combination of environmental changes that affect vectors and wildlife hosts and social changes such as poverty and conflict that affect human exposure to vectors. Kilpatrick and Randolph (2012) further note that pathogens found in new geographic regions are often explosive and cause extensive initial damage. Climate change combined with deforestation, changing land use patterns by humans - with more settlements being developed by clearing forests - and increasing human population leading to increase in demand for food and fiber, are exerting tremendous pressure on natural ecosystems. Increasing contact between human and domestic animals with wildlife is also creating opportunities for pathogens from wildlife to spill over into domestic animals and human populations (Wang & Crameri, 2014).

A wide range of diseases affecting humans (e.g., anthrax, tuberculosis, plague, yellow fever, influenza, etc.) have originated in domestic animals, poultry, and livestock. More recent outbreaks such as Ebola virus and severe acute respiratory syndrome (SARS) coronavirus, have been traced to cave-dwelling bats in Africa and bats and civets, respectively before infecting humans through the wet markets and restaurants of southern China (Leroy et al., 2005; Li et al., 2005). Influenza and coronaviruses top the list of viruses with pandemic potential; both routinely emerge from animal sources (Grange et al., 2021).

The world is increasingly inter-connected. Emerging zoonoses in one country can potentially spread rapidly and widely and become a threat to global health security. Zoonoses are important not only because of high morbidity and mortality placing immense pressure on public health systems but also because they cause significant economic damage through loss in animal trade and travel as well as loss of economic opportunities for the people through loss of livestock (WHO, 2021). Zoonoses also affect food systems leading to food insecurity because of the disruption in the food chains.

Need for Awareness, Education, Information, Training, and Capacity Building on Zoonoses

Lack of awareness, education and information negatively affects zoonoses management programs. Capacity for surveillance, laboratory diagnosis, record keeping and data analysis, researching new and emerging zoonoses and study of disease epidemiology are essential in zoonoses management, but many developing countries are not prepared for these activities (WHO, 2021). Scholars report limited response capacity at the local level in most countries due to lack of awareness, inadequate supplies and human resource quality and quantities (Devleesschauwer et al., 2014). Institutionalized inter-sectoral collaboration between the key sectors, for example, animal health, public health, agriculture, civil society, etc. that are critical for zoonoses management is often slow. Accurate and current information and reports on zoonotic disease situations are difficult to find because of the inability to obtain quality information from the grassroot level and inadequate communication between agencies (WHO, 2021). According to Seimenis (2010) in many countries stringent government policies to manage zoonoses and hesitancy of senior officers to use those policies still prevail. Inadequate information can delay efforts to develop policies, to garner financial support and to launch public awareness campaigns (Seimenis, 2004). Similarly, lack of knowledge about the zoonotic diseases (e.g., *brucellosis*, ebola, anthrax, their causative agents, clinical symptoms, and transmission) among health care workers are hampering zoonoses management in many countries in sub-Saharan Africa (Benon et al., 2018).

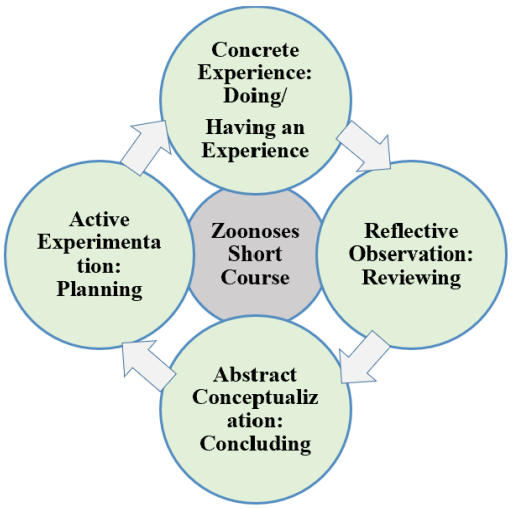
There are several courses and training programs on zoonoses offered in various formats and by many different organizations globally. They include but

are not limited to courses offered by universities (Iowa State University: https://www.cfsph.iastate.edu/product/zoonoses-course/; University of Washington: https://deohs.washington.edu/cohr/zoonotic-disease; University of Vermont: https://learn.uvm.edu/course/202101/15910/spring-2021/public-health/one-health-zoonoses/); international organizations (The International Wildlife Rehabilitation Council (IWRC): https://theiwrc.org/about-us; https://wildlifecontroltraining.com/training/wildlife-diseases/); European Unions: (https://zoeproject.eu/); and public agencies (Texas Department of State and Health Services: https://www.dshs.texas.gov/idcu/health/zoonosis.aspx). To the authors' knowledge, none of the above courses and training programs cover topics from the genesis of zoonoses to planning and management and predicting and preventing future pandemics. Resource persons involved lack diversity in terms of their research, education, and experience. As is obvious from the review, zoonoses are not limited to specific geographic regions and they can spread anywhere across the globe. The recent COVID-19 pandemic (a zoonotic disease) has created a heightened interest in the education, awareness, and capacity building in zoonotic diseases. Approaches to manage outbreaks vary from country to country providing many opportunities for sharing experiences and best practices.

In this context, Michigan State University in collaboration with global partners has developed and piloted an international short course on zoonotic diseases. This course aimed to provide a deeper understanding of zoonoses, including epidemiology, control, and prevention of zoonotic diseases; provide understanding of principles and practices of utilizing the One Health approach; inform about the roles of international organizations, for example, World Health Organization (WHO), World Organization for Animal Health (OIE), Food and Agricultural Organizations for the United Nations (FAO), etc. in zoonoses management; create awareness of impacts of COVID-19 and prevention of future zoonotic diseases; and build a network of professionals working in the field of international zoonoses.

Designing and implementation of this course is based on experiential learning theory posited by Kolb (1984) (Figure 1). The learning cycle begins with exploring, reviewing, and examining the world zoonoses situation and the education and training programs offered globally (Reflective Observation/Diverging). Information collected was critically examined and analyzed which led to the conceptualization of this course (Abstract Conceptualization: Concluding).

Figure 1
Experiential Learning Cycle (Adapted from Kolb, 1984)



Next, the course was designed with objectives and contents, and resource persons were identified, and the course was offered (Active Experimentation: Planning). Finally, participants' experience as well as the organizing team's experience of implementing this course were examined. The experiential learning cycle repeats again, and this goes on with new knowledge generated and shared. As is articulated in the Experiential Learning Cycle, "reflection" is imbedded as a critical element to elevate simple experience to a learning experience, and it is highly recommended to incorporate "reflection" into all activities along the learning cycle of this and other similar educational programs (National Society for Experiential Education, 2021).

Need Identification

The idea for this short course on zoonoses was conceived in early 2020; however, the advent of the COVID-19 pandemic (being a zoonotic disease) encouraged a team at MSU to design and offer this course quickly. There was a growing interest globally for educational and awareness programs related to zoonotic diseases. The MSU team consulted with local, national, and international stakeholders to identify the gaps in areas such as surveillance and disease diagnosis that this could address.

Course Planning

The course was designed in a participatory way. Faculty members across the Colleges of Agriculture and Natural Resources, Veterinary Medicine, and Osteopathic Medicine at MSU and experts from the World Health Organization

(WHO), World Organization for Animal Health (OIE), International Livestock Research Institute (ILRI) and other relevant professionals working in animal health research and education in the United States and around the world were consulted. The course offered elsewhere along with their contents were reviewed and course contents were finalized integrating those inputs. The course components are summarized in Table 1.

Table 1.
Short Course on Zoonoses, Major Course Components

Epidemiology, Control and Prevention of Endemic/Emerging Bacterial, Viral, Parasitic, and Fungal Zoonoses
Zoonotic Diseases of Wildlife Origin
One Health Program: Principles, Practices, and Importance in Zoonoses Management
Roles of WHO, OIE, FAO, and National, Regional and Private Veterinary Services in Zoonoses Management
Public Health Approach to Detecting and Surveillance of Endemic/Emerging Zoonoses
Lessons-learned from COVID-19 and Predicting and Preventing Future Pandemic Zoonoses

The One Health approach has been widely recognized and accepted for zoonoses management globally. "One Health is a collaborative, multisectoral, and trans-disciplinary approach - working at local, regional, national, and global levels - to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants and their shared environment" (One Health Commission, 2021). The One Health approach recognizes that the health of humans is closely connected to the health of animals and our shared environment.

Implementation of the One Health approach has been mixed. The One Health concept is widely accepted in Europe, but is yet to be fully implemented there and more research and education are required to speed up its adoption (Sikkema & Koopmans, 2016). The situation is similar in other continents. It was critically important for participants to know about One Health, therefore, a special session on One Health was required and offered.

International organizations like WHO, FAO, OIE, etc. have the mandate to coordinate with countries to survey disease prevalence and develop international charters, guidelines, protocols, and standard operating procedures and implement them through the member countries. It was therefore essential for professionals in public health, animal health, and associated fields to understand these guidelines, charters, and their implementation modalities. Therefore, a session on **"***Roles of WHO, OIE, and FAO in zoonotic disease management"* was included. It was critical to share experiences and lessons-learned about COVID-19 management in

different parts of the world and co-learn. Thus, sessions on *"Public health approach to detecting and surveillance of endemic/emerging zoonotic diseases"* and *"Lessons-learned on diagnosis and control of COVID-19: A case of Pakistan"* were included.

Wildlife are considered the reservoirs for most zoonotic pathogens. Destruction of habitat for wildlife and increased human/wildlife interactions create a conducive environment for pathogens to escape from their natural hosts and spill over into other animal and human populations. To better understand this phenomenon, two sessions *"Emerging diseases of wildlife with examples of major zoonotic diseases"* and *"Lessons-learned from zoonotic outbreaks of wildlife origin"* were included.

Zoonotic outbreaks can incur trillions of US dollars in costs across the globe and prevention is much more cost-effective than responding to such outbreaks (United Nations Environment Program and International Livestock Research Institute, 2020). Dobson et al. (2020) estimate that the present value of prevention costs for 10 years could be only about 2% of the costs of the COVID-19 pandemic. Accordingly, one of the objectives of this course was to educate participants about major zoonoses prevalent in the world and enable them to predict and prevent future pandemic zoonoses. Thus, the culmination of the course was a panel discussion on *"Lessons-learned from COVID-19 and predicting and preventing future pandemic zoonoses"* organized as the last session.

The course wrapped-up with a reflection on the experience of the course from participants and closing remarks from the organizing committee members. The pre- and post-course surveys were administered to participants, and a portion of the survey results are presented later in the paper.

Participants and Resource Faculty Recruitment

The course was advertised through brochures mailed to institutions within the U.S. and outside and emailed to individuals serving in but not limited to human health, animal health, wildlife, and food safety in developing countries in Asia and Africa. Institutions contacted included FAO, United States Department of Agriculture Foreign Agricultural Service (USDA FAS), OIE, One Health Commission, among others. The course was conducted virtually from March 22-26, 2021 using Zoom (zoom.us). Participants were reminded of the course date along with the detailed program with sessions, speakers, duration, and date and time one week ahead of the scheduled date. They were also provided with a zoom link and a link for a Google shared folder where they could access presentations and reference materials. Speakers were sent a zoom invite about one and half weeks in advance of their scheduled session date and also reminded through email one day prior to the day of their class. They were also provided with a link to the Google shared folder and requested to upload their presentations and reading

materials. Participants were provided access to presentations one day before the scheduled date of the presentation.

Forty-two participants for this course came from 13 countries representing Africa (25), Asia (6), Middle East (5), and the U.S. (5) (Table 2). Almost 40% of participants were female, about half held a master's degree, and 43% had an undergraduate degree. Most participants work in the animal health sector (33%) followed by food safety (20.5%), public health (15.4%), international trade, environmental health, and biosafety. More than two-thirds were senior government employees serving in regulatory and policy positions.

Table 2
Participant Demographics

Particular		Frequency	%
Country (N=42)	Africa (25): Cameroon (1), Ethiopia (7), Ghana (3), Libya (1), Nigeria (2), Rwanda (9), Sudan (1), Tanzania (1), Uganda (1)	25	61.9
	Middle East (5): Egypt	5	11.9
	Asia (6): Cambodia (4), Nepal (2)	6	14.3
	USA (5)	5	11.9
Gender (N=38)	Male	23	60.5
	Female	15	39.5
Education (N=37)	Doctorate	2	5.4
	Master's	18	48.6
	Undergraduate	16	43.2
	Other (DVM)	1	2.7
Professional groups (N=38)	Academician	2	5.3
	Researcher	7	18.4
	Regulator	9	23.7
	Policy maker	8	21.1
	Practitioner	11	28.9
	Other (Government employee)	1	2.6
Primary field of work (N=39)	Public health	6	15.4
	Animal health	13	33.3
	Wildlife	3	7.7
	Food safety	8	20.5
	Other (Trade/International Trade Policy=4, Biology=2, Veterinary Epidemiology and One Health=1)	9	23.1
Sector (N=38)	Private Sector	2	5.3
	Public Sector	26	68.4
	Non-profit/International non-profit	7	18.4
	Other (Government)	3	7.9

The course resource persons represented WHO, OIE, ILRI, Centers for Disease Prevention and Control (CDC), National Wildlife Health Center, National Institutes of Health (NIH), Ghent University, Hanoi University of Public Health, Swedish University of Agricultural Science, Mailman School of Public Health Columbia University, the Global Alliance for Pandemic Preparedness & Response (APAR), Central Health Establishment (CHE) Pakistan, and Michigan State

University. They came from diverse fields representing animal health, public health, wildlife, education, research, and non-profit organizations.

Program Implementation

With the expansion of internet availability, online education and training are on the rise. The current COVID-19 pandemic has further necessitated the adoption of online learning due to mandatory social distancing requirements enacted in many countries. Most educational institutions are using online platforms for teaching. In a study among undergraduate students in the California State University San Bernardino, Ni (2013) found that participation in online learning is less intimidating than in-class learning. In a study among undergraduate students at a university in the Midwestern U.S., Sellnow-Richmond, Strawser and Sellnow (2020) found that students desire more interaction with both peers and instructors in online courses. A study among students of an asynchronous online course in Taiwan, Wei and Chien (2020) found students' computer/internet self-efficacy and motivation for learning had a direct, positive effect on their online discussion scores and course satisfaction. To the authors' knowledge no studies have documented the experiences of designing and implementation of an online zoonoses short course.

The International Zoonoses Short Course sessions started with the Program Manager introducing the speakers and the topics. Participants were encouraged to ask questions throughout. All speakers gave live presentations except one who provided a recorded presentation. There were two sessions scheduled on the first and third day, three on the second, fourth and fifth day.

Knowledge Gains – Pre and Post-Test Results

In order to measure the effectiveness of the content provided during the course, participants were asked to complete a knowledge survey before and after the course. Each question started with "Please indicate your level of knowledge on each of the following topics on or related to zoonoses". Possible responses ranged from 1= "No Knowledge" to 6 = "Very High Knowledge". The paired t-test was used to assess the statistical significance (2 tailed, alpha=0.5) of the difference in mean scores of self-reported knowledge level on 18 different topics before and after the training. Between 30 and 34 people completed each pre- and post-course survey question. A statistically significant ($p<0.05$) gain in self-reported knowledge was found for all 18 topic areas suggesting that the participants found the content provided contributed greatly to improving their level of knowledge. Each topic, pre-test mean and standard deviation, post-test means and standard deviation, degrees of freedom and p-values are presented in Table 3. Participants were asked about the effectiveness of each session with response options being 1 = "Not Effective" to 5 = "Very Effective". The average response for all sessions combined was 4.35 (range 4.1 to 4.5: SD 1.36). For each session, participants were also asked "How useful is this information to

you?" with response options being 1 = "Not Useful" to 5 = "Highly Useful". The average response for all sessions combined was 4.34 (range 4.1 to 4.6: SD 1.45).

Table 3.

Pre- and Posttest Self-reported Knowledge Level (means and standard deviations) on Various Course Topics, Assessment Using Paired T-Test Analysis

Please indicate your level of knowledge on each of the following topics on or related to zoonoses:	**Pretest**		**Posttest**		***D F***	***p*-value (2-tailed)**
	M	***SD***	***M***	***SD***		**Alpha =0.05**
Global status of zoonotic diseases	3.61	0.75	4.91	0.40	32	0.000*
Epidemiology, control, and prevention of the major endemic bacterial zoonoses	3.67	1.10	4.97	0.41	33	0.000*
Epidemiology, control, and prevention of the major emerging bacterial zoonoses	3.56	0.96	4.91	0.41	32	0.000*
Epidemiology, control, and prevention of the major endemic viral zoonoses	3.45	0.79	4.81	0.36	30	0.000*
Epidemiology, control, and prevention of the major emerging viral zoonoses	3.58	1.05	4.71	0.35	31	0.000*
Emerging zoonotic outbreaks of wildlife origin	3.32	1.09	4.74	0.73	31	0.000*
Epidemiology, control, and prevention of the major endemic parasitic zoonoses	3.43	1.43	4.73	0.62	29	0.000*
Epidemiology, control, and prevention of the major emerging parasitic zoonoses	3.39	1.11	4.71	0.55	30	0.000*
Epidemiology, control, and prevention of the major endemic fungal zoonoses	3.06	1.20	4.64	0.50	30	0.000*
Epidemiology, control, and prevention of the major emerging fungal zoonoses	3.03	1.43	4.61	0.65	30	0.000*
One Health Program: Principles and practices	3.69	1.19	4.97	0.55	31	0.000*
World Health Organization (WHO)'s roles on zoonoses management	3.72	0.85	4.81	0.42	31	0.000*
Food and Agriculture Organization of the UN (FAO)'s roles on zoonoses management	3.69	0.93	4.97	0.42	31	0.000*
Federal Government's roles in the investigation and prevention of zoonoses	3.64	1.80	4.82	0.40	32	0.000*
Public health approach for detecting and surveillance of emerging zoonotic diseases	3.50	1.10	4.45	0.05	31	0.000*
Standard setting for zoonotic disease mitigation and prevention as envisioned by the World Animal Health Organization (OIE)	3.45	1.51	4.67	0.48	32	0.000*
World Animal Health Organization (OIE)'s roles for improving animal and public health systems on zoonotic disease management in its members countries	3.64	1.17	4.79	0.42	32	0.000*
Multifaceted effects of COVID-19 pandemic	3.72	1.50	4.81	0.48	31	0.000*

Note. $*p < .001$, 2-tailed test.

Experiences with the Use of Zoom

About half of the respondents (46% of 35) acknowledged facing challenges in learning virtually. Replying to what challenges you faced question, 14 of 15 reported issues with internet connection and three mentioned the difference in time zones. To dive deeper into these challenges, attendees were asked whether they faced any issues using Zoom. Only 3 of 34 indicated they faced issues: taking longer to connect/join and issues with the internet.

Participants' Feedback on the Short Course

When asked "What did you like the most about the course?" top participant answers included: competent and expert resource persons/speakers coming from diverse fields representing many parts of the world (n=9), followed by comprehensive course contents (n=7), and well-organized and ordered sessions (n=6).

"Good professors, everyone was free to interact and ask questions."

"Interactive course, clear and well-organized presentations."

"The caliber of most speakers was superb. I learned a lot and left me wanting more."

"The course covered a wide range of topics."

"The presenters/speakers/panelists mastery of what they were teaching. The organization was thoughtful."

"The selected courses, the presenters and the materials."

"The wide range of presenters and that the PowerPoints are detailed enough that they will be continually useful as a resource."

"Up-to-date contents and resource persons."

"Very informative and educative."

When asked "What did you like least about the course?" participants mentioned: time (short time: n=8, time differences because of participant's different time zones=4). Furthermore, to the question "Please suggest any new topics that you would like us to include in this course" 28 attendees responded with requests to offer more information about Antimicrobial Resistance (AMR) and approach to deal with it (n=2) and roles and responsibilities of governments, researchers, and field practitioners in and strengthening these sectors for zoonoses management (n=3), biosafety, biohazards, biosecurity, biotechnology and zoonoses (n=4), diagnosis of zoonotic diseases (n=2). Additional topics suggested included: epidemiological data analysis using various statistical

software, fieldwork and ecology study on bats/rodents/other wildlife, food safety and quality, hygiene, and HACCP System, zoonoses and the environment for mitigation, challenges in international food trade, public health, research findings-impact of zoonoses on economy, emphasis on One Health, and zoonoses of companion animals (each n=1).

The most suggested method to make this course more effective and participatory was to organize this course in-person or as a residential course with opportunity for hands-on exercises, field tours and laboratory practices (n=9). Including more interactive sessions such as breakout rooms (n=6), learning games and short videos (n=3), and quizzes (n=3) to keep participants engaged and active were other suggestions. A couple participants also suggested creating a WhatsApp group and using it to communicate in the future. Select quotes from the participants are provided below.

> *"I found it participatory. But the breakout room exercise that we did could perhaps be applied more when there is more time."*
>
> *"Increase time of breakthrough rooms, suggest prior to the actual program informal meeting with participants virtually sharing of what they are doing in their country."*
>
> *"It was at its level best. If possible, it would have been more interesting and participatory if it was in person (live) and with more hands-on."*
>
> *"It was very nice methods, but it is better to [make it] participatory and experience sharing.".*
>
> *"It would have been good if it was residential course."*

To a question to provide additional suggestions about the course, if any, 23 participants responded. They reiterated making this course in-person, increasing course and session duration, and making it more interactive. Many of the respondents appreciated the way the course was managed. The following select verbatims are self-explanatory.

> *"Give more time to topics, this course needs [sic] minimum 3 weeks."*
>
> *"I am very happy being part of this and all the presentations are very interesting, and I gained an important knowledge. Thank you very much all the presenters and the team organizing [sic] this course. This type of short course is relevant for us especially for developing country."*
>
> *"I like the course, do not stop it. The course helps more people to be aware of zoonotic diseases. If possible, course timeline should be extended [sic] to one month."*

"I really enjoyed the course and found it very informative. The presentation facilitation and technology were very well done as well."

"Really, I do not have words to thank you, especially [x]. You are very active and excellent in your all things. Thank you very much Dr. xx".

Discussion

Overall, the course was well received by the participants. Significant change in their knowledge level after attending the course compared to their knowledge level prior to the course is clearly demonstrated. The desire of many attendees to make this an in-person course with hands-on opportunities is a common weakness of any virtual educational program, i.e., not being able to provide an opportunity to learners for "learning by seeing" and "learning by doing." Poor internet connectivity could also have significant bearing to the learning as not all people in the world have equal access to reliable internet and digital learning tools and platforms (Dhawan, 2020; Favale et al., 2020). On the positive note, 42 people would not have been able to attend this course and learn about zoonoses had it not been a virtual course. Organizing this course in-person cannot be imagined without securing significant resources and importantly, the ongoing pandemic would not allow travel at the time the course was offered. Attendees' acknowledgment of the diversity and extensive experience and expertise of resource persons is one of the strengths of this course and this was possible because of this course being virtual.

Participants' suggestions to include new topics including but not limited to AMR, biosafety, international trade of livestock and animal source foods, and relationships between zoonoses and environment show increase in importance of, and demand for, deeper discourse on zoonoses and the One Health approach. On the method aspect, suggestions to include more breakout rooms, quizzes, show short videos, and make the course more interactive reiterate the interest and enthusiasm to the course and eagerness to engage in a deeper learning among participants.

Lessons Learned and Way Forward

The course participants represented a diverse group of global stakeholders. There was diversity not only in terms of participant nationalities but also in their backgrounds, professions, knowledgebase, and their experience with zoonoses. Offering a program with contents and delivery methods tailored to meet the needs of this diverse group participants greatly helped make this program successful. Effective communication, teamwork, appreciating and acknowledging each other's contributions, demonstration of flexibility from all concerned (participants, resource persons, management), and good grasp of language were critical to the success of the course.

With regards to the resource persons who volunteered to this course and whom course participants greatly appreciated, meeting with them virtually or talking with them by phone, appreciating them for their responses, tweaking the title and contents of their session per their suggestions, and importantly, debriefing them before the course about course objectives are of paramount importance to build trust and gain their support.

Organizing an online course in an important topic like zoonoses and inviting senior professionals from four continents was challenging but it was worthwhile. It is our belief that Michigan State University's image as a global educational hub has helped to win the trust of the participants and resource persons and sponsors. Overall, the online course on zoonoses has a tremendous scope globally. As suggested by the participants, making this course more interactive and participatory and sharing country examples during sessions and sustaining the quality of the course is critical for its sustainability.

While both online and in person courses have their own pros and cons, it will not be possible to replace one by the other. However, the lessons-learned from this and other online courses should be evaluated in order to update and upgrade future online courses to make them more learner and instructor friendly and interactive. This course could be offered as a hybrid course—both virtually and in-person. The offering of the in-person course however depends on the availability of the resources -- willingness of the participants to pay and willingness of institutions to sponsor their participants. More critically, this will be possible only if the pandemic is contained and controlled and international travel becomes normal. There should be a plan to review the contents per changing needs of the stakeholders and countries.

A One Health approach should continue to be a priority to manage zoonoses. Zoonoses, food safety, international trade, and antimicrobial resistance (AMR) should be discussed given their increasing prominence globally. Not only in the countries in Asia and Africa, AMR is a growing concern in the U.S. as well where more than 2.8 million antibiotic-resistant infections occur each year, and more than 35,000 people die as a result of these resistant infections (CDC, 2019).

Climate change, wildlife habitat destruction caused by human activity, along with the trend of more and more people keeping pet animals are increasing the chances of infection and spread of zoonoses. Therefore, global collaboration and cooperation on research, education and teaching is essential to manage zoonoses.

Heeding to the points raised during the panel discussion, several initiatives have been started. Alliance for Pandemic Preparedness and Response (APAR), one of the collaborators of this course has established an international forum to explore innovative ideas focusing on research, outreach and extension targeting resource poor and marginalized people around the world. Importantly, a book on

zoonoses with chapters referencing country examples from course participants; and a regional conference focusing on zoonoses are being discussed.

References

Benon, A. B., Juliet, K., Samuel, M., Catherine, K., Benjamin, S., Michael, M., & Innocent, R. B. (2018). Health workers' knowledge of zoonotic diseases in an endemic region of Western Uganda. *Zoonoses and Public Health*, *65*(7), 850-858. https://doi.org/10.1111/zph.12509

CDC. (2019). Antibiotic Resistance Threats in the United States, 2019. U.S. Department of Health and Human Services, CDC. http://dx.doi.org/10.15620/cdc:82532

Devleesschauwer, B., Ale, A., Torgerson, P., Praet, N., Maertens de Noordhout, C., Pandey et al. (2014) The Burden of Parasitic Zoonoses in Nepal: A Systematic Review. *PLoS Neglected Tropical Diseases*, 8(1), e2634. https://doi.org/10.1371/journal.pntd.0002634

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5–22. https://doi.org/10.1177/0047239520934018

Dobson, A. P., Pimm, S. L., Hannah, L., Kaufman, L., Ahumada, J. A., Ando, A. W., ... & Vale, M. M. (2020). Ecology and economics for pandemic prevention. *Science, 369* (6502), 379-381. https://science.sciencemag.org/content/369/6502/379/tab-pdf

Favale, T., Soro, F., Trevisan, M., Drago, I., & Mellia, M. (2020). Campus traffic and e-Learning during COVID-19 pandemic. *Computer Networks*, *176*, 107290. https://doi.org/10.1016/j.comnet.2020.107290

Grange, Z. L., Goldstein, T., Johnson, C. K., Anthony, S., Gilardi, K., Daszak, P., ... & PREDICT Consortium. (2021). Ranking the risk of animal-to-human spillover for newly discovered viruses. *Proceedings of the National Academy of Sciences*, *118*(15).

Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, 451, 990–993.

Kilpatrick, A. M., & Randolph, S. E. (2012). Drivers, dynamics, and control of emerging vector-borne zoonotic diseases. *The Lancet, 380*(9857), 1946-1955.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development (Vol. 1). Prentice-Hall.

Leroy, E.M., Kumulungui, B., Pourrut, X., Rouquet, P., Hassanin, A., Yaba, P., Délicat, A., Paweska, J.T., Gonzalez, J.P. & Swanepoel, R. (2005). Fruit bats as reservoirs of Ebola virus. *Nature*, 438, 575–576.

Li, W., Shi Z., Yu M., Ren W., Smith C., Epstein J.H., Wang H., Crameri G., Hu Z., Zhang H., Zhang J., McEachern J., Field H., Daszak P., Eaton B.T., Zhang S. & Wang L.F. (2005). Bats are natural reservoirs of SARS-like coronaviruses. *Science*, 310, 676–679.

National Society for Experiential Education. (2021). *Eight Principles of Good Practice for All Experiential Learning Activities*. https://www.nsee.org/8-principles

Ni, A. Y. (2013). Comparing the effectiveness of classroom and online learning: Teaching research methods, *Journal of Public Affairs Education*, *19*(2),199-215 https://doi.org/10.1080/15236803.2013.12001730

One Health Commission. (2021). What is One Health? https://www.onehealthcommission.org/en/why_one_health/what_is_one_health/

Sellnow-Richmond, D., Strawser, M. G., & Sellnow, D. D. (2020). Student perceptions of teaching effectiveness and learning achievement: A comparative examination of online and hybrid course delivery format. *Communication Teacher*, *34*(3), 248-263.

Seimenis, A. (2004). Problems in multidisciplinary collaboration: The public and animal health issue. Proc. Expert consultation on community based VPH systems, Annex, 8, FAO, Rome, FAO/AGAH/UN, 106-110.

Seimenis, A. (2010). Capacity building for zoonotic and foodborne diseases in the Mediterranean and Middle East regions (an intersectoral WHO/MZCP proposed strategy). *International Journal of Antimicrobial Agents*, 36, S75-S79.

Sikkema, R., & Koopmans, M. (2016). One Health training and research activities in Western Europe. *Infection Ecology & Epidemiology*, *6*(1), 33703.

United Nations Environment Programme and International Livestock Research Institute. (2020). *Preventing the Next Pandemic: Zoonotic diseases and how to break the chain of transmission*. Nairobi, Kenya.

Van Wart, A., O'Brien, T. C., Varvayanis, S., Alder, J., Greenier, J., Layton, R. L., ... & Brady, A. E. (2020). Applying experiential learning to career development training for biomedical graduate students and postdocs: Perspectives on program development and design. *CBE—Life Sciences Education*, *19*(3), es7. https://doi.org/10.1187/cbe.19-12-0270

Wang, L. F., & Crameri, G. (2014). Emerging zoonotic viral diseases. *Revue Scientifique et Technique*, *33*(2), 569-81.

Wei, H., & Chien, C. (2020). Online learning performance and satisfaction: Do perceptions and readiness matter? *Distance Education*, *41*(1), 48-69, https://doi.org/10.1080/01587919.2020.1724768

WHO. (2021). *Regional Committee: Sixty-first session. Zoonotic disease: Emerging public health threats in the Region*. https://www.emro.who.int/about-who/rc61/zoonotic-diseases.html