



An international planetary health for primary care massive open online course

Mayara Floss, Alan Abelson, Aoife Kirk, Su-Ming Khoo, Paulo Hilário Nascimento Saldiva, Roberto Nunes Umpierre, Alice McGushin, Sojung Yoon

In this Viewpoint we argue that primary care practitioners should receive professional education in how to directly respond to planetary health challenges. We reflect on the provision of a massive open online course (MOOC) on planetary health for primary care practitioners in the context of existing training programmes. We describe the construction, delivery, and certification of a Global South-originated MOOC and explain aspects of its rhizomatic learning theory. We share baseline information and preliminary findings collected on the initial cohort of participants, including their profiles and previous knowledge about planetary health. We suggest that this MOOC is an appropriate response to planetary health challenges, and argue that cost-free, accredited planetary health education for primary care practitioners should be provided as a public good that also fulfils individual professionals' entitlement to quality education and continuing professional development.

Introduction

The rapid escalation of the climate crisis, along with the COVID-19 pandemic, shows the inextricable relationships between human health and environmental health¹⁻³ and highlights the need for new transdisciplinary, integrated approaches in education, especially for health-care professionals.² Advocacy for the inclusion of climate and environmental education within medical, primary care, and nursing curricula has increased over the past two decades.^{3,4} In this Viewpoint, we suggest that planetary health education is essential for primary health professionals, in order to prepare them for working on the front line, where the consequences of climate change and its associated disruptions of planetary systems manifest as health-care needs.⁵

Planetary health is defined by The Rockefeller Foundation–*Lancet* Commission as a new field of “health of human civilization and the state of the natural systems on which it depends”.⁶ The interdependence of health and ecosystem health is now more widely recognised, integrating long-standing perspectives, critiques, and needs of Indigenous cultures and minorities. Planetary health frames health in its broader context, understanding the complex interdependent socioecological drivers⁶ of human health and the health of the planet that we inhabit.⁷

Health professionals, in particular primary care teams, are advantageously placed to raise awareness and educate their own communities on the health benefits of planetary health.⁸ Planetary health issues and challenges often manifest as local problems, affecting communities on the front lines, where primary care teams work.⁹⁻¹¹ Planetary crises such as heatwaves, floods, or food insecurity must be addressed locally in communities that are already facing everyday problems, for example from exposure to air pollution. To better equip primary care practitioners around the world, a massive open online course (MOOC) was created by the World Organization of Family Doctors (WONCA) Working Party on the Environment, with funding from WONCA's discretionary funding scheme.

Development on this MOOC began in early 2020, and the course was launched in English on May 5, 2021, as a free, open course hosted by TelessaúdeRS-Federal University of Rio Grande do Sul (UFRGS). This Viewpoint discusses the need for a MOOC that focuses on planetary health and draws on data collected while the course was ongoing to discuss how it could be effective as a training tool for primary care practitioners. The planetary health for primary care MOOC is the first of its kind—a course developed in the Global South for, and by, primary care professionals from around the world. Ensuring a worldwide health-care workforce that is educated in planetary health will require major and ongoing efforts.

Setting

The online course is hosted on the TelessaúdeRS-UFRGS Moodle platform. TelessaúdeRS-UFRGS is a research centre linked to the postgraduate programme in epidemiology, in the faculty of medicine at the UFRGS, which aims to improve the health of the population through telemedicine and telehealth to primary health care teams within Brazil's Unified Health System (Sistema Único de Saúde). Evidence-based, self-instructional distance learning courses are offered for continuing professional development by TelessaúdeRS-UFRGS, free of charge.

Methods

Scoping of existing training programmes

A scoping study of existing online training for health-care professionals on climate change and planetary health was conducted in January, 2020, using internet searches and the snowball method (ie, primarily using the internet sources to find courses with additional information through emails from people who have worked on similar training programmes), following WONCA Working Party on the Environment's recommendations. A set of inclusion and exclusion criteria were developed to ensure only relevant programmes were identified. Courses were studied for their format, content, accessibility, accreditation, and evaluation (appendix p 3).

Lancet Planet Health 2023; 7: e172–78

This online publication has been corrected. The corrected version first appeared at [thelancet.com/planetary-health](https://www.thelancet.com/planetary-health) on April 3, 2023

Faculty of Medicine, Department of Pathology, University of São Paulo, São Paulo, Brazil (M Floss MD); Department of Family and Community Medicine (A Abelson MBChB), Dalla Lana School of Public Health (A Abelson), University of Toronto, Toronto, ON, Canada; The Mater Misericordiae University Hospital, Dublin, Ireland (A Kirk MBChB MPH); Ryan Institute, School of Political Science and Sociology, National University of Ireland Galway, Galway, Ireland (S-M Khoo PhD); Urban Health Laboratory, Faculty of Medicine, University of São Paulo, São Paulo, Brazil (P H N Saldiva PhD); Department of Social Medicine, University of Rio Grande do Sul, Porto Alegre, Brazil (R N Umpierre MD PhD); MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Cambridge, UK (A McGushin MSc); UNICEF, New York, NY, USA (S Yoon MScPH)

Correspondence to: Dr Mayara Floss, Faculty of Medicine, Department of Pathology, University of São Paulo, São Paulo 01246-903, Brazil
mfloss@usp.com

For TelessaúdeRS-UFRGS's Moodle platform see <https://www.ufrgs.br/telessauders/saude-planitaria/>

See Online for appendix

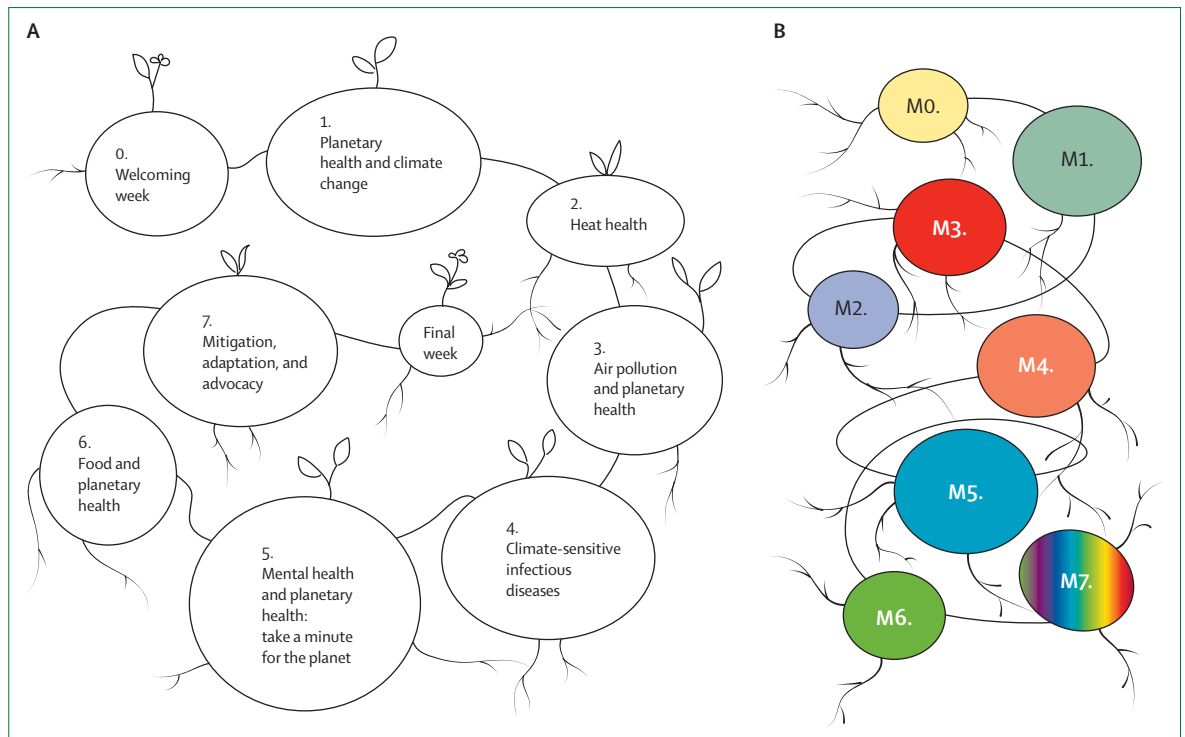


Figure 1: Rhizomatic learning of a massive open online course on planetary health for primary care (A) Rhizomatic structure of planetary health modules and knowledge-building. (B) Learning spiral—an alternate view of the learning process.

Course structure

The project aimed to develop an online training programme that introduces planetary health to family doctors and other primary health-care practitioners, to inspire and guide education and advocacy. The course was initially designed to supplement a new WONCA training initiative called the Air Health Train the Trainer programme.¹² The pilot programme of this initiative taught 73 health-care practitioners in low-income and middle-income countries (LMICs) about air pollution and health. The structure of the course was adapted from the Brazilian Planetary Health Pilot Course,¹³ developed in Brazil in partnership with TelessaúdeRS-UFRGS.¹³

The MOOC's seven modules include: planetary health and climate change; heat health; air pollution; climate-sensitive infectious diseases; mental health and planetary health; food and planetary health; and climate change mitigation, adaptation, and advocacy. Each module was developed by a different team, with each module leader recruiting and coordinating a research and course-writing team comprising members from both high-income countries (HICs) and LMICs.

Each module was reviewed by at least two expert topic leaders, and a high-level review of the entire course was done by three international experts. The modules follow a standard structure, starting with objectives, a case study that generates questions for discussion, and a content section that offers clinical and community interventions. Interspersed within the modules are links to suggested

reading, videos, and other resources. A glossary of key terms and definitions, references, and further suggested reading and activities are provided at the end of each module. Completion of each module was marked by the award of a digital badge—ie, a microcredential symbolising the module—with the design of each badge linked to a story from diverse localities (appendix p 5).

A forum section in each module includes song suggestions, art interventions, and stimulating discussions to use the creative arts to complement and deepen the effect of the scientific content discussed. Modules were designed to take 5 h of study for completion. Certification was provided by the TelessaúdeRS-UFRGS after completion of knowledge evaluations at both the beginning and end of each module. Each module was interconnected and could be explored in different ways, through reading, reflections, forums, activities, or exploring the stories linked to the module badges. Thus, various pedagogical tools are used to provoke critical reflection and new ways of thinking.

We conceived the learning process as a rhizome (figure 1A) or spiral (figure 1B) of transformative education, which takes the learner beyond knowledge assimilation or reproduction, to integrate critical reflection and emergent learning. A rhizome characterises learning from a multiplicity of starting points. Learnings do not originate from a single module or end in a single endpoint in the learning journey. Rhizomatic and spiral learning structures aim to break down constricted, silo mentality.

The MOOC's target audience is family doctors and primary care practitioners worldwide, but the modules can be used by other medical specialists, nurses, community health workers, allied health-care professionals, and students. Creative, aesthetic design was integral to the development of the project (appendix p 6), with blue representing the planet's sky and water, green representing vegetation, and orange and yellow representing the rising sun and rejuvenation. A hand represents both primary care, in which knowledge is put into practice, and the transdisciplinarity of planetary health. The illustrations were minimalist and simple, to lighten the heavy cognitive and information content of the course.

Study design and data collection

Ongoing course evaluation seeks to understand how participants understood planetary health before taking the course and how they experienced the course. All 472 participants were asked to indicate their consent to participate in research related to the course when starting the MOOC. We collected information on 115 (24%) participants' demographic profiles, and questions with structured response categories and open-ended questions. This information generated both qualitative and quantitative data. We surveyed participants who engaged with the course between May 5 and Dec 31, 2021. The course was still running when the data were collected. Data collection was approved by the ethics committee of the Grupo Hospitalar Conceição (CAAE 25272619.7.0000.5530).

Data analysis

Quantitative analysis of the course survey (closed-ended questions) using Excel software is ongoing at the time of writing this Viewpoint. Qualitative survey responses (open-ended questions) were coded into themes, and further refined through two rounds of coding. The coding process was analysed using MAXQDA (version 2022) software.

Preliminary findings

Existing online training courses

A total of seven online training courses for health-care professionals on climate change and planetary health were identified in January, 2020, through the scoping review (appendix p 3). Most courses originated from the Global North and followed similar formats including video recordings. Several had interactive components, such as discussion forums and quizzes. All of the courses had a general focus, and did not examine the effect on any particular region or differential effect of climate change with respect to country income or development status, except the Warren Alpert Medical School course, which is focused on the USA, and the McMaster University course, which is focused on Canada (appendix p 3).

Three of the seven courses had some form of participant evaluation survey at the end of the course.

Course participants: characteristics and initial responses

Participants were recruited mainly through WONCA environment email lists, the WONCA website and the TelessaúdeRS-UFRGS website, and social media. Of the 472 participants who enrolled in the course between May 5 and Dec 31, 2021, 118 (25%) agreed to participate in the study, of which 115 (24%) completed the demographic information and an initial survey evaluating their previous knowledge about planetary health. At the time of writing, 35 (7%) participants had completed the whole course, 21 (60%) of whom had consented to share the data and completed the end-of-course satisfaction survey. A total of 217 certificates were generated (appendix p 7).

60 participants were from LMICs, 42 of whom were from Brazil (70%), with others distributed across all regions of the world, and 53 participants were from HICs, eight of whom were from Ireland (15%) and another eight from France (15%); two participants left the question blank (figure 2).

When providing their areas of work, 56 (49%) of 115 participants said primary care, 12 (10%) said they were undergraduate students, ten (9%) said in a hospital, and 14 (12%) said they worked in education. Some medical specialists, including infectious disease specialists and ophthalmologists also enrolled in the course. Participants from non-medical institutions included those from non-governmental organisations, the UN, and public health research.

29 (25%) of 115 participants were currently in residency or postgraduate specialist training, 18 (16%) had completed specialist training or multi-professional residency, 12 (10%) were undergraduate students, 20 (17%) had completed or were currently studying for a Masters degree, and 20 (17%) had completed or were currently undertaking a Doctoral degree. There were two middle school participants (aged 17 years and 20 years) and one high school participant (aged 27 years).

Other demographic data, such as age and gender, are described in the appendix (p 8). Most participants (87 [76%] of 115) worked in urban areas, with just 14 (12%) in rural areas; one participant did not answer this question, and the remaining 14 (12%) included retired individuals and people who work in both rural and urban places. When choosing their self-identified genders, 66 (57%) of 115 participants answered cisgender woman, 45 (39%) participants answered cisgender man, two (2%) participants answered non-binary, one (1%) participant answered transgender man, and one (1%) participant answered transgender woman. The largest age group represented in the study was 26–30 years, consistent with the early career stage of the professions.

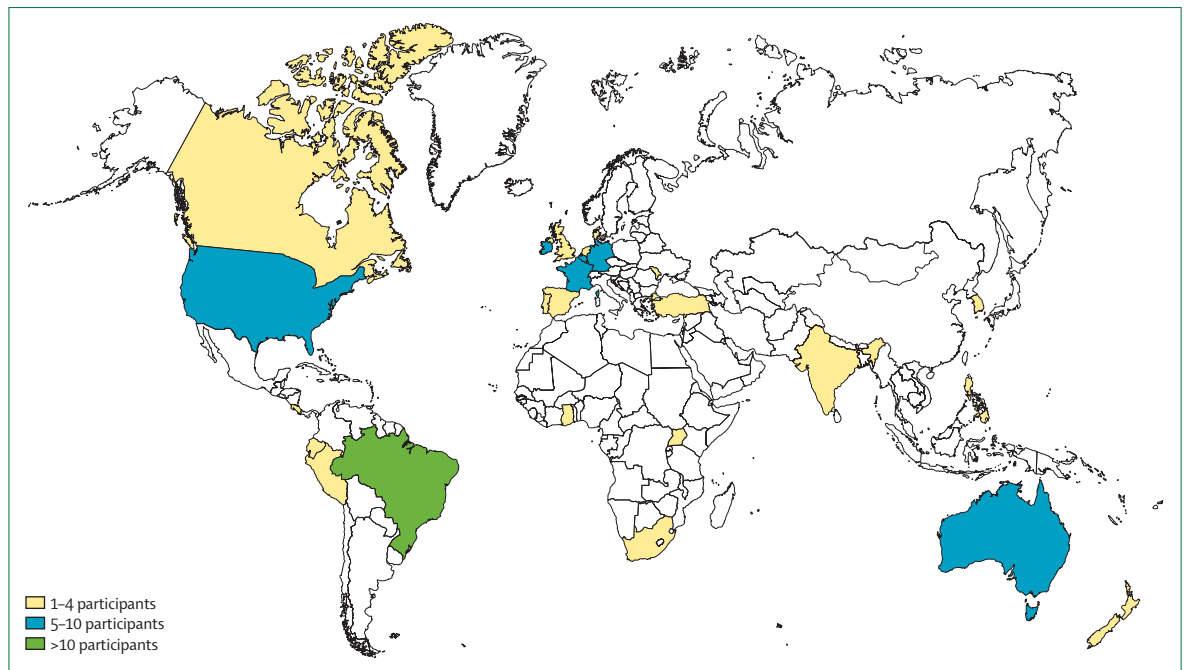


Figure 2: Country distribution of survey participants

When asked: “Have you heard of the term planetary health?”, 106 (92%) of the 115 participants said yes, seven (6%) said no, and two (2%) said maybe. Responses from those reporting some knowledge about planetary health to the question “How did you have your first contact with the topic?” are shown in figure 3. Of the 11 participants who responded with other, they said that they learned from conferences, the UN Climate Change Learning Partnership, a book called *Planetary Health: protecting nature to protect ourselves*,¹⁴ information from the International Federation of Medical Students’ Associations-Brazil, and the Planetary Health Academy Lecture Series from the German Climate Change and Health Alliance.

When asked the pre-course question: “What is your level of concern about climate change?”, one (1%) participant chose little concern, three (3%) chose cautious, none chose indifferent, 46 (40%) chose worried, and 65 (57%) chose alarmed. When asked, “How important do you think it is for health professionals to be able to identify health problems associated with planetary health?”: before the course started, 106 (92%) participants answered “this is necessary”, five (4%) answered “this is useful, but not a priority”, none answered “this is not necessary”, and four (3%) answered “I need more information before I decide”. Of the 21 people that completed all modules of the course, 20 (95%) answered “this is necessary”, one (5%) answered “this is useful, but not a priority”, and none answered “this is not necessary” or “I need more information before I decide”. It is possible that participants who answered “this is necessary” were more likely to finish the course. Analysis of the 115 responses to the open

question “What does planetary health mean to you?” suggested ten themes for further analysis (appendix p 9).

Discussion

We are not yet able to fully analyse and report on the complete results of the course evaluation as the course has not yet been completed by some participants. Nevertheless, we offer this Viewpoint to advance some general points about the urgent need for planetary health education for primary care practitioners and to share our experience from the creation and development of this MOOC. Although it is challenging to capture the effect and transformative potential of any education and training intervention, future iterations and evaluations of this MOOC could ask participants how they intend to apply their learning in primary care.

Writing as primary care practitioners and allies, we call for planetary health education for, and by, primary care practitioners as a crucial tool to prepare ourselves for planetary challenges. We want to play our part in adapting health-care settings to planetary health challenges, but also to bring about wider health system awareness and transformation in line with primary health-care values. In designing, delivering, and surveying the participants of a planetary health MOOC, we also recognise substantial limitations, including a low completion rate (low completion is a noted characteristic of MOOCs; however, we might compare this known trend with the completion rate of the study by Floss and colleagues,¹³ which showed a notably higher than the typical low completion rate of MOOCs for a similar southern-origin MOOC). Another possible

bias is that the course reaches participants that were already interested in planetary health.

The planetary health MOOC draws upon principles of primary health care to anticipate the possibility of transformation towards planetary health care.⁵ Targeting primary care practitioners is important since primary care will be the first line of response for people seeking care when environmental change, destruction, and pollution intensify intersecting risks such as disasters, extreme temperatures, zoonotic disease, and food insecurity.

The universal, equitable, and public aspirations of primary care are crucial, given the unabated inequalities of environmental harms and risks.^{15–17} Most thematic responses clustered around the themes of planet and human link, and environment as a human health determinant (appendix p 9).

Given the uneven distributions of risks and impacts across the globe, it is important to emphasise planetary health education. Adult—or andragogical—learning theory assumes that a learner’s re-assessment of their own attitudes, beliefs, values, and behaviours leads to sustained change. Most of the participants were already concerned or alarmed about health problems related to planetary health.¹⁸ Yet merely participating in and completing an educational module on planetary health cannot guarantee that participants or their situations have actually changed. The complexity of the planetary and public health nexus requires the cultivation of critical and reflexive learning that is driven by values and principles, but is also rhizomatic in its approach. A linear approach to education and learning premised on linear educational causality simply cannot be expected to meet the complexity and extremity of planetary health challenges.

The planetary health MOOC adopts a rhizomatic, rather than a linear approach while appreciating that any course or curriculum must retain some concrete, coherent, and developmental structural characteristics. The rhizomatic concept draws from Deleuze’s theory, which seeks to critique or deterritorialise institutional forms and reterritorialise more open-ended alternatives, where a rhizome is analogous to the botanical structure, representing the logic of the “and”.¹⁹ The logic of “and” in Deleuzian theory is analogous to the transdisciplinary principle of the included middle, that A does not exclude B, but both A and B are included.¹⁹ The concept of rhizomatic education is explored in a community-based MOOC led by Cormier to respond to the educational uncertainty, abundance, and choice offered by the internet with a distinctive combination of online focus, connection to nature, and a powerful educational philosophy committed to community learning.¹⁹ Linear, objective, and outcomes-based learning might not be compatible with subjective and inter-subjective rhizomatic learning. Furthermore, inter-subjective rhizomatic learning could be difficult to measure objectively.

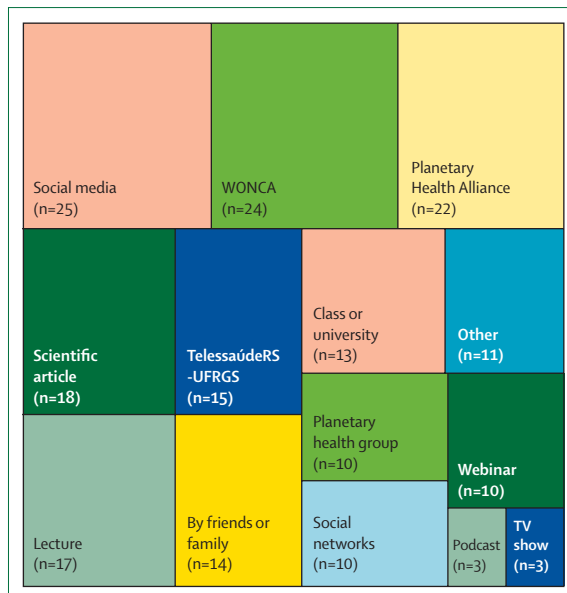


Figure 3: Answers to the question: “How did you have your first contact with the topic [planetary health]?”

195 total answers, but participants could choose more than one option. Of the 11 participants who responded with other, they said that they learned from conferences, the UN Climate Change Learning Partnership, a book called *Planetary Health: protecting nature to protect ourselves*,¹⁴ information from the International Federation of Medical Students’ Associations-Brazil, and the Planetary Health Academy Lecture Series from the German Climate Change and Health Alliance. UFRGS=Federal University of Rio Grande do Sul. WONCA=World Organization of Family Doctors.

The planetary health MOOC’s rhizomatic structure is organised in a way that places the learner among a group of things²⁰—eg, the student is in nature, not external to it. Each module started with a case study, followed by a structure that included questions. An artistic perspective was included using design and discussion forums. The rhizomatic format attempted to highlight other layers of the educational experience by using different kinds of communication to reach beyond cultural change and the banking approach,²¹ targeting the acquisition of some quantity of scientific and technical knowledge about planetary health.¹⁴ Transformative learning that engages learners emotionally, offers hope, and moves the learner towards critical thinking²² is a key pedagogical approach to move people towards the attainment of planetary health care.

From a different starting point, we might consider integrating planetary health into primary care principles. The Planetary Health Alliance advocates for the inclusion of planetary health care as an eighth attribute to the primary care framework.⁵ They suggest that this addition will underpin the primary care framework with planetary health principles including: interconnection within nature, equity and social justice, systems and complex thinking, acknowledgment of the state of health in the Anthropocene,²³ and movement building for systems change.

For this community-based MOOC see <https://courses.p2pu.org/en/courses/882/rhizomatic-learning-the-community-is-the-curriculum/>

Most of the participants in the planetary health for primary care MOOC had previously been introduced to the theme of planetary health through climate change education and climate change awareness raising, encountering this topic through social media, WONCA, and the Planetary Health Alliance. Formal medical education was very seldom a route of introduction; only 10 (9%) of 106 valid answers reported having learned about planetary health in university classes (figure 3). These data illustrate the urgency of collaborative and interdisciplinary or transdisciplinary efforts to bring planetary health into every medical and health curriculum.⁸ In 2022, WHO called for climate change education to be strengthened in health professionals' curricula.²⁴ Professional medical and health education should be a key support for the future of planetary health—it should not be left to chance.

Studies from the Global North on elite MOOCs show that the benefits of MOOC offerings disproportionately benefit better-resourced and privileged professionals—eg, men and people holding high educational qualifications.^{25–27} In contrast, a southern-initiated MOOC proposal could potentially attract less-represented and less-resourced learners in the Global South, especially those coming from less-advantaged groups. The involvement of a national higher education and telemedicine partnership (eg, TelessaúdeRS-UFRGS) in outreach and accreditation, as well as the integration of the principles of primary health care and open education enhance the MOOC's potential as a tool for social justice and inclusion, through the integration of planetary health care as a primary care principle and part of a primary care framework.

The participants of the MOOC so far have mainly been young and women, indicating a different demographic reached than that of more elite, Global-North-initiated MOOCs. In the first roll-out of the MOOC, the largest proportion of participants were from Brazil, reflecting the existing strong role of TelessaúdeRS-UFRGS in educating primary health care professionals locally. Although the MOOC had some worldwide distribution, the global reach of the course could be improved, which the course team hope to enhance by translation into more languages, starting with French in the near future. As most participants indicated that they were already alarmed or very concerned about climate change, it is the planetary health topic that they are already most sensitised to and it is, therefore, a key starting point for transformative planetary health education. However, this response also shows that there is a large selection bias and that people who are already concerned about climate change are likely to pursue course offerings in planetary health.

This planetary health MOOC for primary care practitioners was conceived, designed, and run by an international collaborative team from both LMICs and HICs who are explicitly committed to challenging south–north asymmetries, starting from a distinctively

Global South as well as a generally equity-oriented perspective on global open education. The course is offered at no cost to the learner; free certification is important in ensuring the right to access quality education not as a commodity, but as a global public good.^{28,29} This part of the course aligns with the 2030 Sustainable Development Goals target 4.7: “ensure all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development”.³⁰ Meanwhile, the climate action target 13.3 also requires all societies to: “improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning”.³¹

For the Global South and Global North alike, it seems particularly important to de-commodify planetary health education, emphasising the principle of education as a public good and a means of inculcating public ethics above education as a business oriented towards individual advancement.³² Education towards planetary health care extends primary health care ethics towards a new domain of Earth ethics.¹⁴ We suspect that it will be impossible to achieve real change, to preserve an adequate level of planetary health for all within the necessarily urgent timeframe, if our health-care education remains constrained and overdetermined by a commodified and business-driven paradigm.

To conclude, we reiterate that there is an urgent need to promote the theme of planetary health through professional education. Together with many collaborators and learners, we see the effort to construct the course and to learn from running it as a positive action to empower primary care practitioners and to offer some of the necessary knowledge, skills, motivation, and opportunities for reflection and change that are required to respond to health needs arising on a planet that is experiencing multiple planetary crises, with multiple impacts on the health and wellbeing of people and the planet.

Contributors

MF, AA, and AK designed the data collection tools, monitored data collection for the whole study, wrote the analysis plan, cleaned and analysed the data, and drafted and revised the paper. MF, AA, AK, S-MK, PHNS, AM, RNU, and SY analysed the data, and drafted and revised the paper.

Declaration of interests

AA, AM, and MF report grants from WONCA during the conduct of this study. All other authors declare no competing interests.

Acknowledgments

We would like to thank Roberto Nunes Umpierre, coordinator of the TelessaúdeRS-UFRGS team for kindly helping us develop this course and for hosting this course freely on their platform. In particular, we would like to thank the education team Ana Paula Borngräber Corrêa and Angélica Dias Pinheiro; the design team coordinator Camila Camini; the visual identity design team Pedro Vinícius Santos Lima and Davi Adorna;

and Lorena Bendati Bello for the course. Finally, we also want to thank all of the people involved in the development of this course, especially Enrique Falceto de Barros and the whole WONCA Environment group. This Viewpoint represents the authors' own views. Research for this Viewpoint did not receive any funding.

References

- 1 Romanello M, McGushin A, Di Napoli C, et al. The 2021 report of the *Lancet* Countdown on health and climate change: code red for a healthy future. *Lancet* 2021; **398**: 1619–62.
- 2 Knechtges PL, Kelley TR. Educating future environmental health professionals. *Environ Health Insights* 2015; **9**: 23–26.
- 3 Shaw E, Walpole S, McLean M, et al. AMEE Consensus Statement: planetary health and education for sustainable healthcare. *Med Teach* 2021; **43**: 272–86.
- 4 Wise J. Climate crisis: over 200 health journals urge world leaders to tackle “catastrophic harm”. *BMJ* 2021; **374**: n2177.
- 5 de Barros EF, Floss M, Guinto R, et al. Planetary health care and Barbara Starfield’s legacy. June 10, 2021. <https://blogs.bmj.com/bmjgh/2021/06/10/planetary-health-care/> (accessed Dec 8, 2021).
- 6 Whitmee S, Haines A, Beyrer C, et al. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–*Lancet* Commission on planetary health. *Lancet* 2015; **386**: 1973–2028.
- 7 Prescott S, Logan A, Albrecht G, et al. The Canmore Declaration: statement of principles for planetary health. *Challenges* 2018; **9**: 31.
- 8 Omrani OE, Dafallah A, Castillo BP, et al. Envisioning planetary health in every medical curriculum: an international medical student organization’s perspective. *Med Teach* 2020; **42**: 1107–11.
- 9 Xie E, de Barros EF, Abelsohn A, Stein AT, Haines A. Challenges and opportunities in planetary health for primary care providers. *Lancet Planet Health* 2018; **2**: e185–87.
- 10 André H, Gonzalez Holguera J, Depoux A, et al. Talking about climate change and environmental degradation with patients in primary care: a cross-sectional survey on knowledge, potential domains of action and points of view of general practitioners. *Int J Environ Res Public Health* 2022; **19**: 4901.
- 11 MacNeill AJ, McGain F, Sherman JD. Planetary health care: a framework for sustainable health systems. *Lancet Planet Health* 2021; **5**: e66–68.
- 12 McGushin A, Falceto de Barros E, Floss M, et al. The World Organization of Family Doctors Air Health Train the Trainer Program: lessons learned and implications for planetary health education. *Lancet Planet Health* 2023; **7**: e55–63.
- 13 Floss M, Vieira Ilgenfritz CA, Rodrigues YE, et al. Development and assessment of a Brazilian pilot massive open online course in planetary health education: an innovative model for primary care professionals and community training. *Front Public Health* 2021; **9**: 663783.
- 14 Myers S, Frumkin H. Planetary health: protecting nature to protect ourselves. Washington, DC: Island Press, 2020.
- 15 Frosch RM, Pastor M, Sadd J, Shonkoff S. The climate gap. In: Hamin Infield EM, Abunnasr Y, Ryan RL, eds. Planning for climate change, 1st edn. Abingdon-on-Thames: Routledge, 2018: 138–50.
- 16 Nazrul IS, Winkel J. Climate change and social inequality. Oct 17, 2017. <https://www.un.org/en/desa/climate-change-and-social-inequality> (accessed Aug 30, 2022).
- 17 Sultana F. The unbearable heaviness of climate coloniality. *Polit Geogr* 2022; **99**: 102638.
- 18 Christie M, Carey M, Robertson A, Grainger P. Putting transformative learning theory into practice. *Aust J Adult Learn* 2015; **55**: 9–30.
- 19 Harris D. Rhizomatic education and Deleuzian theory. *Open Learn* 2016; **31**: 219–32.
- 20 Deleuze G, Guattari F. A thousand plateaus, vol 1. Capitalism and schizophrenia, 2nd edn. São Paulo: Editora 34, 2011 (in Portuguese).
- 21 Freire P. Pedagogy of the oppressed. London: Penguin Classics, 2017.
- 22 Freire P. Pedagogy of hope: reliving pedagogy of the oppressed. London: Bloomsbury Academic, 2014.
- 23 Lewis SL, Maslin MA. Defining the anthropocene. *Nature* 2015; **519**: 171–80.
- 24 WHO. A call for strengthening climate change education for all health professionals: an open letter to universities and all education stakeholders. June, 2022. <https://climateandhealthalliance.org/wp-content/uploads/2022/06/Curriculum-letter.pdf> (accessed Aug 2, 2022).
- 25 Zhenghao C, Alcorn B, Christensen G, Eriksson N, Koller D, Emanuel EJ. Who’s benefiting from MOOCs, and why. Sept 22, 2015. <https://hbr.org/2015/09/whos-benefiting-from-moocs-and-why> (accessed Aug 14, 2021).
- 26 Ruipérez-Valiente JA, Staubitz T, Jenner M, et al. Large scale analytics of global and regional MOOC providers: differences in learners’ demographics, preferences, and perceptions. *Comput Educ* 2022; **180**: 104426.
- 27 Dillahunt TR, Wang BZ, Teasley S. Democratizing higher education: exploring MOOC use among those who cannot afford a formal education. *Ini Rev Res Open Dis* 2014; **15** (suppl): 1 (abstr).
- 28 UNESCO. Target 4.7 | Sustainable development and global citizenship. Aug 10, 2016. <http://gem-report-2016.unesco.org/en/chapter/target-4-7-sustainable-development-and-global-citizenship/> (accessed Aug 31, 2022).
- 29 Bridge 47. How SDG Target 4.7 accelerates Agenda 2030 progress. <https://www.bridge47.org/news/07/2022/how-sdg-target-4-7-accelerates-agenda-2030-progress> (accessed Aug 31, 2022).
- 30 UN environment programme. GOAL 4: quality education. Feb 10, 2017. <http://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-4> (accessed Aug 31, 2022).
- 31 The Global Goals. 13: climate action. <https://globalgoals.org/goals/13-climate-action/> (accessed Sept 3, 2022).
- 32 Lane A, Caird S, Weller M. The potential social, economic and environmental benefits of MOOCs: operational and historical comparisons with a massive ‘closed online’ course. *Open Prax* 2014; **6**: 115–23.

Copyright © 2023 The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY-NC-ND 4.0 license.