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Published in:
Medical Teacher

DOI:
10.1080/0142159X.2022.2118041

Embedding planetary health concepts in a pre-medical and health professional pathway Physiology subject

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Embedding planetary health concepts in a pre-medical Physiology subject

Purpose: There are increasing calls for planetary health (which includes sustainable healthcare) to be included in tertiary health professions education. With already busy curricula, particularly in medicine, educators need to find innovative ways of integrating these important concepts without adding to learners' workload. This study investigated whether planetary health concepts could be integrated into a Physiology subject as a stop-gap approach while longitudinal planning for longitudinal curriculum integration was underway. **Materials and methods:** Each week, a planetary health fact (*Did you know?*) with a corresponding link were embedded at the bottom of a relevant PowerPoint lecture slide to match the topic of the week in a health science and medicine Physiology subject. The embedded facts were a mix of effects on health and the environmental impacts of healthcare activities, such as medical imaging. No other formal planetary health teaching was conducted in the subject. At the end of the semester, 44% of 100 students completed a survey regarding their perceptions of the planetary health inclusions. **Results:** Participants reported an appreciation of the facts, found them helpful for their overall learning, and were interested in learning about healthcare's large environmental footprint. Seventy-one percent were able to provide a reasonable definition of planetary health. Half of the participants reported their actions, behaviours, and thoughts had changed as a result of the planetary health inclusions. **Conclusions:** This study provides a relatively simple approach for individual educators to include planetary health concepts into existing health professions subjects until more longitudinal curriculum revisions can be undertaken. Based on our findings, we would, however, recommend providing students with a brief introduction in terms of why planetary health has been included either at the start of the first lecture or as a 10-minute video.

Keywords: health professions education; climate change; planetary health; sustainable healthcare; just-in-time teaching; medical education.

Practice points

- There have been numerous calls to include planetary health in medical and health science curricula.
- In an already overloaded curriculum, integrating planetary health content can be a daunting task.
- Health professions educators need to find innovative ways of integrating planetary health concepts into existing subjects.
- Integrating planetary health facts can enhance health professions students' awareness of the environment as a determinant of health and what needs to be done to reduce our impact, especially in terms of the environmental and footprint of healthcare.
- It is recommended to include a definition of planetary health and its relevance to health professions students at the start of the subject.

Introduction

Due to an economic reliance upon fossil fuels, particularly in high income countries, greenhouse gas (GHG) emissions have been rising and natural resources have been depleted faster than they can be replenished (United Nations Environment Programme Copenhagen Climate Centre 2020). A Code Red for a healthy planet and for humans has been declared (Romanello et al. 2021; Intergovernmental Panel on Climate Change 2022). Considering the large environmental footprint of healthcare (Lenzen et al. 2020), which could be up to 10% of a country's emissions, there have been increasing calls from professional bodies (Shaw et al. 2021) and from students (Hampshire et al. 2022), for health professions curricula to prepare students with the knowledge, skills and values to be able to tackle the threats to the human health and the health of the planet (McLean et al. 2020; McLean and Gibbs 2022). This interrelationship between the health of the planet and human health is now the new discipline of planetary health (Horton et al. 2014). While definitions of planetary health vary, this one from Whitmee et al. (2015) is probably the most widely used: '*Planetary health is the achievement of the highest attainable standard of health, wellbeing, and equity worldwide through judicious attention to the human systems—political, economic, and social—that shape the future of humanity and the Earth's natural systems that define the safe environmental limits within which humanity can flourish'* (p. 1978).

Health professions education has, however, been relatively slow to include, for example, climate change issues or sustainable health care in curricula (Marill 2020; Rabin et al. 2020). To this end in medical education, an international student-led study found that only 15% and 11% of medical programs globally had included the health impacts of climate change and air pollution, respectively, in the curriculum (Omrani et al. 2020), despite both already being concerning environmental determinants of health.

Based on the events of the past few years, i.e. the hottest years on record for many countries, wildfires, droughts and, more recently, the COVID-19 pandemic, considerable progress has been made in terms of many health professions institutions including or beginning to include sustainable healthcare, climate change, One Health and/or planetary health in their curricula (Hampshire et al. 2022).

Numerous barriers, however, exist to including new content such as the ecological determinants of health (Parkes et al. 2020) and sustainable healthcare in health professions education. These include an already busy curriculum, with students commonly reporting feeling overwhelmed (Kopel et al. 2021) and exhausted educators, some of whom may not be sufficiently knowledgeable in planetary health (Tun 2019; Tun et al. 2020).

Bearing in mind these barriers, this study set out to explore the feasibility of embedding planetary health concepts, which incorporate a 'did you know' fact relevant to the content, along with a written solution and reference for further reading, into an existing first-year Physiology subject undertaken. It drew on the recommendation of the recent Association for Medical Education in Europe Consensus Statement on Planetary Health and Education for Sustainable Healthcare, co-authored by 35 educators and students in several health professions, to integrate planetary health in the curriculum (Shaw et al. 2021). As an example of how this was undertaken in the Physiology subject, in a session in which medical imaging was indicated, a single 'fact' mentioned that the contrast agent commonly used for some magnetic resonance imaging (MRI) scans contains gadolinium, which, after excretion by the patient a few days later, cannot be removed by the municipal sewerage treatment facilities, and becomes toxic to fish life around the plant's wastewater efflux (Inoue et al. 2020). While this information should not impact a clinician's decision when an MRI is necessary, it should influence

the clinician's decision to select, when appropriate, a less environmentally harmful imaging modality or to not request any imaging if there are no red flags such as for lower back pain (Choosing Wisely Australia 2022).

As longitudinal integration of planetary health across a curriculum reform may take years to implement, it makes sense to use just-in-time learning, i.e. presenting short snippets of information where appropriate (López Cupita 2016). There are two immediate advantages to this approach that address some of the identified barriers: An individual educator can undertake this integration at relatively short notice and since the snippet of content, often clinical, is professionally relevant in terms of real-world contexts, learners are more likely to engage without being overwhelmed.

Thus, this study was guided by the research question, *would adding planetary health concepts in the form of short informative facts to existing lecture presentations be sufficient to stimulate students' interest?* This study evaluated this just-in-time intervention as a possible first step of integrating planetary health into a first-year Physiology subject for health professions students in a pre-health pathway. If students were amenable to such an intervention, then it could be promoted as a relatively easy and efficient way for individual health professions educators to respond to the calls to include planetary health education in the curriculum without adding too much to the curriculum until longitudinal integration is undertaken.

Materials and Methods

Study design

Participants and study setting

First-year students (n = 100) undertaking a 12-week Physiology subject at an Australian university were eligible to participate in this study. Students included those enrolled in biomedical science, health science, and exercise science as well as medical students completing a pre-medical pathway. Students were not exposed to any planetary health content in any of other subjects or within their respective degree programs.

Integrating weekly planetary health facts

A new topic was introduced each week in the Physiology subject covering tissues, organ systems, and physiology concepts. Weekly content delivery comprised a 50-minute lecture (theory) followed by a 1-hour tutorial (application). The PowerPoint lecture slides were released at the start of each week, allowing students to prepare for the lecture. Twelve planetary health facts or concepts (one per week) were introduced during the weekly lecture (Table 1). On an appropriate PowerPoint slide, a relevant planetary health fact (*Did you know?*) was inserted in the bottom left-hand corner and a relevant solution and link was provided in the bottom right-hand corner (Figure 1). When the slide with the planetary health fact was displayed, it was highlighted by the educator, although no substantial time was devoted to discussing this inclusion in either the lecture or tutorial time. In line with the interrelationship between the health of the planet and human health, the facts spanned the environment as a determinant of health (e.g., global warming, air pollution, vector-borne diseases, nature prescribing) as well as the environmental impact of healthcare (e.g., medical imaging).

Table 1. Summary of planetary health statements ('facts') included on the PowerPoint lecture slides, as well as the solution and reference for further reading.

Weekly lecture topic	**Did you know?**	**Planetary health solution**	**Reference provided to students**
1: Body organs	Air pollution kills ~7 million people annually worldwide. Data show 99% of the population breathe air that exceeds WHO guideline limits containing high levels of pollutants.	Accelerate the move to renewables and reduce the burning of fossil fuels. Consider respiratory health in clinical assessments, particularly in major cities and high-exposure regions.	World Health Organisation 2022. https://www.who.int/health-topics
2: Skin	A warmer climate will expose humans to a wide range of skin infections and disorders, including cutaneous infections, thermal injuries, and diseases.	Reduce global greenhouse gas emissions, wastes, and plant more trees.	Herring and Lindesay 2022. https://www.climate.gov/
3: Cells	Normal cells work best at ~37 °C, but with rising temperatures, this can impact human physiology. Heat affects every part of our body, leading to heat exhaustion, heat stroke, anxiety, impaired cognitive function, and even premature death from heart and lung disease.	All countries need to adopt reduced emissions targets by 2030 and aim to prevent deforestation as trees reduce both heat and carbon.	Tummula 2020. https://www.scientificamerican.com
4: Tissues	The millions of pathology tests performed each year involve transportation and laboratory equipment (using electricity, gases, refrigeration and generating waste and emissions).	Reduce unnecessary testing and motivate clinicians to test wisely.	McAlister et al. 2020. doi: 10.5694/mja2.50583
5: Epithelia	As global temperatures rise, shorter winters and greater UVR intensity will increase annual sun exposure and exacerbate skin cancer incidence, which arises from damage to the squamous cells in the epithelial tissue.	Reduce emissions of fossil fuels. Cycling or walking to work/university, avoid eating fast foods, etc. Many of the interventions beneficial for the planet are also beneficial for personal health too!	Parker 2020. doi: 10.1016/j.ijwd.2020.07.003
6: Blood	Climate change promotes outbreaks of vector-borne disease. Such events could exacerbate existing shortfalls in blood supply and compromise transfusion safety.	Reduce greenhouse gas emissions (e.g., refuse to buy new stuff, fix old, seek out sustainable products for items of necessity, reduce red meat intake). A global effort would help to stabilise the climate.	Bambrick et al. 2009. doi: 10.3402/gha.v2i0.2059
7: Body fluids	We are about 60% water in terms of body weight, but 1 in 3 people does not have access to safe drinking water and 2 out of 5 do not have a basic hand-washing facility.	2018-2028 is the Water Action Decade. Take action, become informed, speak up, be the change.	United Nations 2022. https://www.un.org/sustainabledevelopment

8: Bone physiology	For developing bones, a healthy diet is required to prevent, e.g., rickets (due to calcium and phosphorus deficiency) and mental retardation in children. But, 2.37 billion people are without food or unable to eat a healthy balanced diet.	Food security, nutrition, and sustainable agriculture are key to ensuring global food sources while lowering the footprint of agriculture.	United Nations 2022. https://sdgs.un.org
9: Bone repair	Bone injuries are a major cause of child hospitalisations. This results in the use of diagnostic imaging, medications, single-use plastics and more for assessment and treatment.	Safer cities prevent injury. There is already an overuse of diagnostic imaging, so fewer injuries result in a lower planetary impact from this aspect of healthcare.	O'Sullivan et al. 2018. doi: 10.1136/bmjopen-2017-018557
10: Nerves	MRI scans often require injection of a contrast agent. This is excreted in urine, cannot be removed by water treatment, and is toxic to the environment.	Choose wisely to see if there is a need to scan. If a scan is necessary, then provide collection and waste options for urination after contrast agents have been administered.	Inoue et al. 2020. doi: 10.1016/j.marpolbul.2020.111148
11: Brain	In Australia, ~46% of people aged 18-85 have experienced a mental health disorder in their lifetime. Typically, medication is prescribed but pharmaceuticals contribute 19% of the Australian healthcare system's carbon emissions.	Aim to provide non-drug interventions where possible/feasible. e.g., In Canada, health providers are trialling prescribing time in 'nature' instead of drugs for stress, to reduce inflammation, blood pressure, etc.	Australian Government 2020. https://www.aihw.gov.au
12: Muscle	Our muscles are developed to work within a specific thermal range. If the outside temperature is too warm, the body cannot cool down during exercise, impacting performance. Increasing global temperatures may impact athletic performance due to the influence on muscle performance.	Reduce global greenhouse gas emissions, wastes, and plant more trees and restore ecosystems.	James and Tallis 2019. doi: 10.1093/conphys/coz066

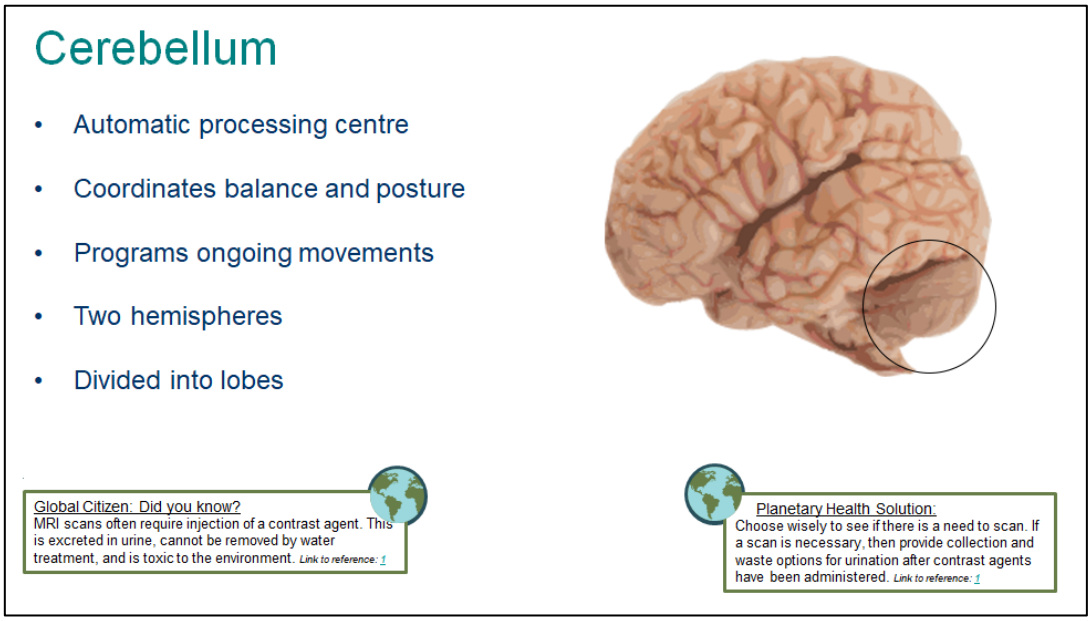

Figure 1. Exemplar of a planetary health fact and accompanying resource provided on one slide from a 50-minute lecture in Week 10 of a first-year Physiology subject.

After considerable discussion, it was decided to not include any formal introduction to or a definition of planetary health at the start of the subject. This would allow us to evaluate whether the inclusion of 12 relevant planetary health facts was sufficient to engage students and stimulate learning. It is important to note that as this was a pilot study, the planetary health content was not assessed.

Data collection and analysis

Development of the survey instrument

An online survey (six seven-point Likert scale items; four open-ended questions) was created using Qualtrics XM (Qualtrics, Provo, UT) to collect participant perceptions of the embedded planetary health facts in the Physiology subject (Appendix 1). The open-ended questions (no word limit) were included to evaluate whether students engaged with the planetary health inclusions, whether they sought additional information on a

particular topic, and whether more (or less) planetary health content should be incorporated into other subjects in the program. In addition, one open-ended item asked them to provide a definition of planetary health.

Towards the end of the semester, the survey was advertised to students who were then invited to evaluate the planetary health intervention during the allocated lecture time. Participation was voluntary, and all participants provided informed consent via an online form on Qualtrics XM prior to the commencement of the survey.

Survey reliability and validity

To validate the survey, five academics with experience educating first-year health sciences and medical students assessed its face value. Each item was assessed for clarity, relevance, format, simplicity, grammatical construction, and comprehensibility. No participants had any queries regarding any survey items. The six Likert scale items were deemed to have good internal consistency based on the Cronbach Alpha value (α = 0.8) using SPSS v26 (IBM SPSS, Chicago, US).

Open-ended item analysis

Using the Whitmee et al.'s (2015) definition of planetary health provided earlier, student definitions were graded between 0-2 (2 being the most comprehensive): Two (2) points for the interrelationship between the health of the planet and human health; 1.5 points if the interrelationship was missing but both human health and health of the planet were mentioned; one (1) point for the health of the planet or the environment; 0.5 points if there was a mention of the need to protect the environment; and zero (0) for a vague definition that did not mention any of the required definition points. To assess whether there was any relationship between the graded definition of planetary health

and a student's response to the Likert scale item 'I can confidently explain to others what planetary health is', a correlation coefficient (r) was applied, where $p < 0.05$ was considered statistically significant.

To evaluate participants' written responses to the open-ended questions, a conceptual approach to content analysis (Krippendorff 2018) was undertaken to determine the existence and frequency of concepts in a text. The content was coded for certain concepts and inferences made based on the emerging patterns.

Ethics

The survey was anonymous. After reading an explanatory statement, participants provided their informed consent to participate. Ethics for this study was approved by the University Human Ethics Committee.

Results

Participant perceptions of embedding planetary health

Forty-four percent of the 100 enrolled students aged between 18 and 25 years completed the survey. Figure 2 summarises the results for the six Likert-scale items which suggests an overall positive response to the inclusion of the planetary health facts in the Physiology subject. The most positive responses were the items relating to the need to protect the environment and including planetary health concepts in other subjects. There was, however, some ambivalence to the content being assessed.

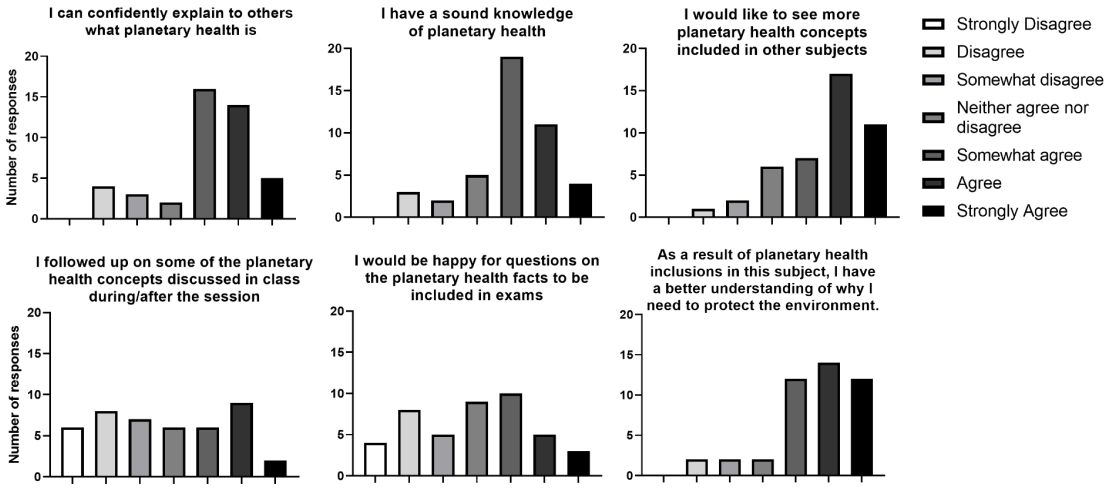

Figure 2. Participant perceptions of the embedded planetary health concepts in a first-year Physiology subject ($n = 44$). Data are reported on a 7-point Likert scale (*1 = strongly disagree* to *7 = strongly agree*).

Rating definition of planetary health

Thirty-eight participants (86% of respondents) provided a definition of planetary health without looking it up. Although only one student was able to provide a comprehensive definition, 71% of students achieved a score of at least 50% for their definition (Table 2). A weak positive correlation was identified between the score allocated to participant definitions and their self-declared ability to define planetary health (correlation coefficient, r (35) = 0.19, p = NSD). Students receiving a low score for their definition also reported a lack of knowledge of planetary health for this Likert scale question. This suggests that students do have some general insight into their overall ability to comprehend the area, although there remains a substantial need for additional learning.

Table 2. Student definitions of planetary health scored using Whitmee et al. (2015) definition (n = 38).

Score (/2)	Example participant definition	Score justification	%
2	'Planetary health refers to the interconnectedness of human activity and our health and that of the planet.' (P3)	Definition includes the interrelationship between the health of the planet and human health.	3
1.5	'Planetary health is a way of making our planet better and being a good citizen by understanding the contributing factors.' (P26)	Missing the interdependence.	13
1	'Actions that are deteriorating or seriously impacting the environment.' (P8)	Only the health of the environment in the definition.	55
0.5	'The effect on the planet.' (P36)	Mentions only the need to protect the environment, without any detail of what or why.	11
0	'Less human impact.' (P15)	Too vague, does not include any required points relevant to a definition.	18

Content analysis

Follow-up of planetary health concepts

Fifty-nine percent of participants (n = 26) provided a written comment regarding whether they followed up on any planetary health concepts. Thirty-one percent of these responders (n = 8) reported following up on some of the presented planetary health facts, with areas of interest being medical imaging (n = 4), the impact of warming temperatures on body performance (n = 2), and waste separation (n = 2). An example of a participant comment relating to medical imaging included:

'How when we have a scan e.g., MRI or CTC scan and there is a solution injected into a patient, that is not able to be recycled or broken down and makes its way

into oceans when leaving the body which harms the ocean significantly. I found it really interesting!' (P19).

Suggestions to improve the inclusion of planetary health content across the curriculum

Thirty-four percent (n = 15) of participants responded to the question '*Do you have any suggestions for how we could incorporate more planetary health content across the overall curriculum?'* Three indicated for no change as they were happy with the current approach. Suggestions offered included:

- Incorporate formative quiz-style questions alongside the current embedded concepts (n = 4).
- Include whole slides so they were more noticeable (n = 3).
- Introduce a new subject altogether related to planetary health (n = 2).
- Have an expert for a guest session (n = 1).
- Introduce a laboratory session about reducing waste (n = 1).
- Compare normal physiology content with geophysiology (n = 1).

Personal response following the intervention

Thirty participants provided a response to the question *'Have any of your actions, behaviours, or thoughts changed as a result of the planetary health inclusions in this subject?*'. Half responded Yes (n = 15), 20% responded Somewhat (n = 6), and 30% responded No (n = 9). Participants valued the reminder about the health sector's environmental impact and reported feeling more conscious of these impacts. Common themes in terms of enhanced awareness included the footprint of medical testing (n = 4), and pharmaceutical and laboratory waste (n = 2). Another participant commented that the planetary health concepts '*definitely helped me become more conscious about*

different effects that things we may not expect have (e.g., X-rays and stuff). I think if there was more of them it could help others become more aware' (P36). Participants also reported being more aware of their personal environmental footprint. For example, one participant commented that they are now '*more cautious about waste in the lab*' (P32).

Comments from participants who indicated 'somewhat', included '*My actions have not changed, however, it is good to learn and know about planetary health*' (P19), and '*Not particularly but a lot of it I knew already. I appreciated the reminder that the planet's health affects all of us*' (P33). Participants who responded 'no' to this question regarding changes in actions, behaviours, or thoughts did not provide an explanation.

Discussion

In current health professions curricula, there is little room to introduce new content, making it challenging for educators to respond to the calls for the inclusion of planetary health education. The present study offers a simple approach for individual educators to include planetary health content to bridge the gap between already busy curricula and future curriculum renewal. That students responded favourably to the just-in-time inclusions that were relevant to both human health and the health of the planet is encouraging, allowing educators to proceed with additional integration across other subjects. Student suggestions such as inviting an expert as a guest lecturer would add value.

The clinical nature of some of the facts, such as the environmental footprint of imaging and the waste generated from delivering healthcare (hence the need for more sustainable healthcare), clearly struck a chord with a number of participants, some of whom were likely to be aspiring medical students. The most encouraging response

(89% of respondents) was the acknowledgement that in the overall message of the 12 embedded snippets, there was a need to protect the environment.

Having made the conscious decision to not provide any introduction to planetary health in terms of why it was being included or a definition (to minimise any compounding factors), our research findings suggest that a relatively low-key intervention (in this case, the just-in-time snippets) can be integrated into an existing health sciences or health professions subject, with students engaging and some exploring facts further. Although 71% of respondents provided a definition of planetary health that would have allowed them to 'pass' (50%+) had this been an assessment item, and despite two Likert scale items suggesting that they generally felt confident to explain planetary health to someone and that they had learnt about planetary health, the missing element in their definition was the interrelationship between human health and the health of the planet. Their awareness was more focused on the anthropogenic environmental damage, which in itself is an important consideration. Thus, in the next iteration of this subject, a brief rationale will be presented in terms of the relevance of planetary health for health professions graduates. This may be either at the first session or a short 10-minute video could be made available for students at the outset of the course.

As stated earlier, the planetary health content was not assessed in this pilot study, the primary aim being to explore the feasibility of a just-in-time approach. As assessment drives learning, this did run the risk of the snippets being ignored. That 44% of the students completed the survey and were largely positive about the inclusions, with some exploring topics further, and could provide a reasonable definition for planetary health, suggests engagement and genuine interest. This may relate to the fact that the snippets were relevant to their future careers as health professionals, and

perhaps that as young people, they are concerned about their futures in light of COVID-19, as well as the fires and floods that many have experienced recently. Over the past few years, medical students, in particular, have not only been calling for climate change, sustainable healthcare, and/or planetary health education, but have designed curricula (Wabnitz et al. 2020) and developed institutional self-audit tools, such as the Planetary Health Report Card (Hampshire et al. 2022).

Moving forward, this study suggests that a just-in-time intervention, such as the one we have described, can be adopted by individual educators as the first step to integrating planetary health into health sciences and health professions education until more formal longitudinal curriculum inclusion is undertaken. If several educators across the curriculum collaborated and introduced similar integration in a spiral fashion across different subjects in an undergraduate health science or health professions degree, it may be possible to map core planetary health elements. This 'core' could later be adapted to develop a curriculum theme with constructive alignment in terms of learning outcomes and assessment.

Health professions curricula generally suffer curriculum overload as new content is added without removing other outdated content. As planetary health needs to be integrated across the curriculum, the time is now right for institutions offering health professions education to invest in a curriculum renewal process. This will ensure that health professions graduates are fit for practice in terms of not only being able to deal with the range of environmental factors that currently impact human health but will also need to be taking action to reduce healthcare's environmental footprint and also contribute to restoring the natural systems on which our health depends (Shaw et al. 2021).

Thus, in terms of Kirkpatrick's hierarchy of outcomes following this educational intervention (Kirkpatrick 1967), there was a reasonable degree of satisfaction (Level 1). Measuring outcomes beyond learner satisfaction is, however, challenging. While we did not assess the content, with 71% of students able to provide a definition of planetary health in which they scored at least 50% (without an introductory definition), this could be taken as a Level 2 achievement in the short term. When asked about whether they changed their behaviours, actions, or thoughts, 50% responded yes, and an additional 20% responded 'somewhat', suggesting some achievement of Level 3.

Limitations

This study was limited in that it was a convenience sample in one subject in a health science and medical faculty and so the data may not be applicable in different contexts. In addition, the 44% of students who completed the survey may have been those who made an effort to engage with the content. The spread of responses does suggest, however, that there were some who were not in agreement (although not vehemently) with some statements, such as '*Doesn't seem relevant to the current course*' (P3) and '*My actions have not changed, however, it is good to learn and know about planetary health*' (P33). Not assessing the content may have disincentivised some students. Also, for students struggling with the workload of a four-subject semester, the additional 12 facts may have been a bridge too far.

Conclusions

This study suggests that the inclusion of just-in-time planetary health facts in an existing Physiology subject for a range of health sciences and health professions students is a feasible stop-gap approach for enhancing their awareness of the environment as a

determinant of health and the need for the healthcare system to reduce its environmental footprint. It is, however, recommended that the rationale for the inclusion be provided as well as a definition (as there are many). This approach can be undertaken by individual educators integrating contextually relevant facts without adding too much additional content. We also recommend assessing the content, but this would require alignment with appropriate learning outcomes. The next step would be to integrate relevant planetary health content across the curriculum, but this will require considerable curriculum redesign to identify what is currently core and remove outdated content. Including a longitudinal planetary health curriculum spiral will require trimming of existing content. This may require faculty development to overcome some of the identified barriers relating to exhausted staff who may not be experts in planetary health topics.

Disclosure of interest

The authors report there are no competing interests to declare.

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Figure captions

Figure 1. Exemplar of a planetary health fact and accompanying resource provided on one slide from a 50-minute lecture in Week 10 of a first-year Physiology subject.

Figure 2. Participant perceptions of the embedded planetary health concepts in a first-year Physiology subject (n = 44). Data are reported on a 7-point Likert scale (*1 = strongly disagree* to *7 = strongly agree*).