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Planetary Health—Global Environmental Change and Emerging Infectious Disease: A New Undergraduate Online Asynchronous Course

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Abstract: Will a warmer world be a sicker world? What is it about the New England landscape that supports the proliferation of Lyme disease? How are local wildlife trade and global species invasions contributors to emerging diseases such as the 2003 outbreak of monkey pox virus in the midwestern United States? Undergraduate students explore these and related questions in BIOL 1455 *Planetary Health: global environmental change and emerging infectious disease*—a new online asynchronous course at Brown University. Planetary health is gaining traction in the curricula of institutions of higher learning and online asynchronous courses offer the promise of scaling up to make grand challenges education accessible to many. In our new course, we assessed student learning outcomes (LOs) and sentiment towards the health of humans and the planet using a mixed-methods approach. Students demonstrated competency in each of the LOs after course completion as measured in a pre–post assessment scored with a standardized rubric. Student sentiment was analyzed with an immersion–crystallization qualitative analysis to elucidate themes in responses to the assessments. Many themes on the pre-assessment focused on barriers and problems associated with the health of humans and the planet, while themes on the post-assessment centered on more solutions-based thinking. Collectively, these findings indicate that this online asynchronous course successfully educated students about the myriad challenges facing human and planetary health, broadened knowledge of environmental changes (beyond climate change) that impact health, formalized understanding of now common terms such as “emerging infectious diseases”, and bolstered hope by offering solutions and peer community (even when virtual). Future efforts to integrate planetary health into higher education should focus on broadly accessible and scalable courses, full programs of study (i.e., majors/scholarly concentrations), and extension into institutional programs focused on ensuring equity and wellness for all.



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1. Introduction

Planetary health seeks to understand and act on the human-caused disruptions of Earth’s natural systems that harm human health and well-being. Higher education has been called to action for its “unique positioning within societies worldwide, as respected sources of thought leadership, and as crucial stakeholders in development efforts” to address the planet’s grand challenges [1]. A growing number of planetary health educational efforts are testament to the students, scholars, and institutions worldwide who prioritize learning in this timely field. At present, +80 medical schools participate in the Planetary Health Report Card Initiative and +150 entries have been made into the Planetary Health Alliance’s Education Resource Database including in person and virtual formal lessons and courses from K-12 to graduate-level, degree programs, experiential learning opportunities, and more.

At our own institution, Brown University's Division of Biology and Medicine, faculty and students have come together to ensure that students in all cohorts, from the undergraduate college to the medical school, have access to planetary health education. Efforts to date have included a formal commitment to longitudinally integrate planetary health throughout the curriculum at the Warren Alpert Medical School, implementation of a planetary health scholarly theme in the Health & Human Biology Undergraduate Concentration (Brown University uses the term concentration for major), and new online asynchronous course offerings in planetary health accessible to undergraduates studying in any scholarly discipline. Here, we share student learning outcomes from the latter—an offering developed to fill a gap in undergraduate planetary health education.

Of the ~150 resources cataloged in the Planetary Health Alliance's Education Resource Database, 18 are noted as undergraduate courses at an accredited institution of higher education and 14 are cataloged as online/open access. The breadth of content encapsulated by the study of planetary health is made apparent in the focal areas of these courses. While several appear to be broad survey courses, most offer a deeper dive into specific thematic areas including health economics, sustainable agriculture, clean energy, climate change, social determinants of health, and more. A survey of the institutions and individuals offering these learning opportunities reveal a range of disciplines with interest in planetary health including the medical and veterinary sciences, public health, environmental science, and economics. Of the resources cataloged as an online or undergraduate course, only five (excluding this one) mention environment-infectious disease linkages in the summary provided, and only one focuses exclusively on this particular thematic area (*Environmental Change and Infectious Disease*, an in-person undergraduate course offered at Stanford University). While the Planetary Health Alliance's Education Resource Database is unlikely to capture all of the educational offerings on the topic, its existing catalog suggests that the majority of planetary health courses are offered in person and targeted to those pursuing advanced degrees or general audiences. Relatively few courses are offered in an online modality or focused at the undergraduate level.

BIOL 1455 *Planetary Health: global environmental change and emerging infectious disease* is a new fully online asynchronous undergraduate course in the Division of Biology and Medicine at Brown University. The course was developed to meet growing student interest in planetary health broadly, and infectious disease-environment linkages specifically—especially following the emergence of COVID-19. Our institution offers no other courses on planetary health in general, or with specific focus on disease emergence and environmental change. BIOL 1455 students learn how, when, where, and why infectious diseases emerge in association with anthropogenic environmental impacts, specifically land-use change, increased human interaction with wild and domestic animals at local and global scales, and climate change. This is accomplished through a range of pedagogies and assessments including micro lectures, primary literature assignments, quizzes, virtual discussion with peers/instructors, reflections, and student choice projects (i.e., an op-ed on a topic of choice relevant to the field and a general audience two-pager on a zoonotic infectious disease). BIOL 1455 was informed by the array of educational resources available via the Planetary Health Alliance and specifically imparts several of the 12 cross-cutting principles for planetary health education: communication (through an array of choose-your-audience projects and opportunities to turn in assignments via video, audio, or writing), systems thinking (via a specific lesson on the topic followed by opportunities to practice it and identify it in case studies), and inequality and inequity (in lessons and assignments where students consider and identify disparities in disease emergence).

BIOL 1455 was developed to be fully online asynchronous to meet a university-wide need for such courses in summer and winter sessions when students are not on campus but interested in continuing learning through credit-bearing coursework. The course was developed with Brown University's Digital Learning and Design team to ensure an inclusive and accessible learning environment for all students. The course is in accordance with ADA requirements for digital accessibility (<https://www.w3.org/TR/WCAG21/>

(accessed on 1 June 2022)). The course capped enrollment at 15 students for the offerings presented here, and was open to any concentration, any cohort from sophomore to senior year, and therefore had no prerequisites. The course aims to be high impact through project-based, interactive and reflective learning, and relies on one undergraduate teaching assistant previously successful as an enrolled student in the course. The syllabus is included in the Supplementary Materials.

We set out to assess student learning outcomes and sentiment towards the health of humans and the planet using a mixed-methods approach in both the summer 2022 and winter 2023 offerings of BIOL 1455. Of particular interest was student sentiment about the state of planetary health and how a course on the topic may influence perspectives. Indeed, a growing body of evidence indicates that global environmental change and paucity of governmental response dually cause anxiety that may negatively impact the mental health and well-being of people worldwide, and young people in particular [2,3]. BIOL 1455 was designed with a solutions-based framework and structured to prioritize regular student engagement with one another, the teaching assistant, and instructor to facilitate sharing of sentiment towards our changing planet. Indeed, the intention during initial course development was to focus on solutions and a sense of community to help allay student anxiety.

2. Materials and Methods

The Brown University IRB considered this study a program evaluation that did not meet the federal definition of human subjects research and therefore did not require review. For this report, we selected representative quotes that did not identify students, and did not include all student responses to avoid the sharing of personal identifying information in written comments.

Student feedback was captured via standardized course evaluations administered by the university. Feedback systematically focuses on the level of student satisfaction with their own effort, course content, structure, and instruction via Likert scale scoring and open-ended response.

Pre- and post-course assessments were used to determine if learning objectives were achieved (see syllabus in supplementary material). Assessment questions were aligned directly with learning objectives, open-ended response, and scored using a rubric (supplementary material) for the purposes of this study, but not for student grading in the course. Full completion of all assessment questions was required of students, however, so as to capture a robust set of responses. Dependent two-tailed t-test was used to identify change in student knowledge from prior to the start of the course (before any course materials were accessible to students) and at the close of the course, and between summer and winter session cohorts. Students had 120 min to complete the assessments.

In both pre- and post-assessments, students were required to reflect, in narrative form, on their personal feelings surrounding the health of humans and the planet: *“Please reflect on how you feel personally/emotionally about the state of Planetary Health at this time. Here we ask you to specifically reflect on the environmental changes underway on the planet that you know about, and the impacts these have on human health and well-being. Are you optimistic, hopeful, pessimistic, unsure, frustrated, etc? Please strive to share your emotion and feeling about the topic as much as you can using a descriptive narrative.”* Sentiment reflections were analyzed with immersion–crystallization, a qualitative analysis method commonly used in healthcare, social science, and related disciplines to identify themes within original text and other sources [4,5]. Examples of its breadth of use range from exploring patient–clinician communication [6], to the role of spirituality in diabetes management, and investigating the benefits and risks of growing up in the farmland environment [7,8]. Three authors (excluding the instructor) applied immersion–crystallization analysis to identify themes through ongoing conversations, crafted definitions to provide context, and selected representative quotes for illustration. For each cohort (winter/summer), two authors read each pre- and post-assessment response and identified themes individually. The authors then met

to discuss themes and generate consensus on the themes, including naming the themes, composing definitions, and identifying representative quotes.

3. Results

3.1. Course Enrollment and Feedback

Twenty-seven students enrolled in the winter 2022 ($n = 14$) and summer 2022 ($n = 13$) offerings of BIOL 1455. Students in their sophomore, junior, and senior years enrolled and represented the following concentrations (the first four being the most common in both offerings): biology, environmental science, health and human biology, public health, anthropology, computational biology, computer science, economics, engineering, history, neuroscience, and sociology. Student feedback indicated a high level of satisfaction in both summer and winter offerings of BIOL 1455 (response rates: summer 9/14, 64.3%; winter 7/15, 46.7%). Students responded to the item, "Overall, I rate this course as effective" on a Likert-type 5-point rating scale. Every student in the summer and winter cohorts strongly agreed or agreed with that statement.

3.2. Assessment of Student Learning Outcomes

We matched complete pre- and post-assessment responses ($n = 24$) for students across the two course offerings who completed both assessments after determining they were not significantly different from one another. Results of dependent t-tests revealed a statistically significant accumulation of knowledge from pre-assessment to post-assessment across all eight questions and total overall score. Mean scores on the total overall post-assessment ($M = 1178.3$, $SD = 116.8$) were significantly higher than the mean scores on the total overall pre-assessment ($M = 758.2$, $SD = 302.3$, $p < 0.001$). The decrease in standard deviation from pre- to post-assessment indicated student knowledge levels were more similar at the end of the course than prior to the start (Table 1).

Table 1. Direct assessment results.

Question	Pre-Assessment		Post-Assessment		Sig.
	Mean	SD	Mean	SD	
1. Define "Planetary Health." Provide up to 5 examples of the kinds of topics the field focuses on. Provide up to 5 reasons why the field of planetary health is important.	191.8	74.6	269.2	31.2	$p < 0.001$
2. Define a "patient-Planetary Health co-benefit." Provide up to 5 examples of patient-planetary health co-benefits.	95.0	75.7	189.2	19.5	$p < 0.001$
3. Define "emerging infectious disease." Explain if and how human emerging infectious diseases increased or decreased globally over the last century in terms of (a) total number of emerging infectious diseases, (b) different types of emerging infectious diseases, and (c) the geographic occurrence of emerging infectious diseases (i.e., where they occur)?	43.6	25.6	458.3	40.8	$p < 0.001$
4. Define "zoonotic infectious disease." List up to 5 examples of infectious diseases that are zoonotic. Pick one zoonotic infectious disease and describe (a) how it transmits (spreads) between hosts, (b) name the host species it originates in, and (c) list up to 3 symptoms it causes in humans.	203.6	102.4	289.2	42.1	$p = 0.004$
5. Name and describe 1 example of an emerging infectious disease in humans that was the result (in full or in part) of climate change. Explain how climate change led to the emergence of the disease. Name and describe 1 example of an emerging infectious disease in humans and/or wildlife that was the result (in full or in part) of species invasion/animal trade. Explain how species invasion/animal trade led to the emergence of the disease. Name and describe 1 example of an emerging infectious disease in humans and/or wildlife that was the result (in full or in part) of land-use change. Explain how land-use change led to the emergence of the disease.	83.6	95.8	300.0	0.0	$p < 0.001$

Table 1. *Cont.*

Question	Pre-Assessment		Post-Assessment		Sig.
	Mean	SD	Mean	SD	
6. Name and describe 1 example that illustrates how an environmental change led to an infectious disease outcome in humans that disproportionately affected certain populations over others.	37.1	37.6	90.0	22.8	$p < 0.001$
7. List up to 5 actions that can help to prevent infectious disease emergence in humans resulting from environmental change. Provide one upside and one downside for each action listed.	52.1	31.9	88.3	16.6	$p < 0.001$
8. State if you believe COVID-19 originated in a lab or natural setting and provide up to 3 evidence-based reasons to support your answer.	51.4	34.6	94.2	11.0	$p < 0.001$
Total overall score on the assessment	758.2	302.3	1778.3	116.8	$p < 0.001$

3.3. Pre-Assessment Student Sentiment

Immersion–crystallization analysis revealed five themes each in the summer and winter cohorts. From these, two common themes emerged: politicization of climate change as a barrier to taking action and the unequal impacts of climate change across communities (Table 2). Specific themes for the summer cohort included the impact of climate change on human health, a society geared against climate reality, and corporate responsibility (Table 3). Specific themes for the winter cohort included a sense of helplessness about the state of our planet, the interrelatedness of disciplines in planetary health, and the importance of knowledge for oneself and others (Table 4).

3.4. Post-Assessment Student Sentiment

Immersion–crystallization analysis revealed five themes each in the summer and winter cohorts. Two common themes emerged: knowledge as power and the impacts of COVID-19/spillover events on planetary health (Table 2). Themes specific to the summer cohort included individual agency, corporate interests, and generational impacts (Table 3). Specific themes for the winter cohort included that the engagement of others to change behavior is difficult but solutions do exist, increased cautionary optimism with limited hope for the future, and the importance of collaboration in creating and implementing solutions (Table 4).

Table 2. Indirect assessment results: Areas of thematic agreement. Each theme is defined based on responses from both the summer and winter cohorts. Representative quotes illustrate the similarities among responses.

	Themes	Definition	Summer	Winter
Pre-Assessment	Politicization	Politicization of climate change as a barrier to taking action.	“The constant politicization of climate change is, quite frankly, annoying because the science and data behind its legitimacy are not deceptive.”	“Overall, I do hope that there will be a solution to the climate crisis sooner than later, but I don’t know how realistic it is to think that national governments will take action before it’s too late—since the effects of rising CO ₂ levels have a delayed impact, once it’s bad enough to clearly mandate action, actions to reduce emissions will only mitigate damages but not stop them.”
	Disparities	Unequal impacts of climate change across geographies, and communities.	“Climate change also seems to be outpacing the rate at which we can get adequate healthcare structures in place to treat those who are experiencing the health effects of the climate crisis.”	“Especially with growing disparities in healthcare access and conditions between developing and developed nations, the negative effects of these disruptions are felt considerably when we look at case studies in specific locales.”

Table 2. *Cont.*

	Themes	Definition	Summer	Winter
Post-Assessment	Knowledge gained	Knowledge as power, and using knowledge to be more hopeful.	“I hope to use my knowledge for good and to make a lasting impact on our Planetary Health, as this course has given me the tools necessary to do just that.”	“Overall though, I am glad that I had the opportunity to learn about a topic which I otherwise did not know a lot about, and I am hopeful about my ability to make at least some contribution towards furthering the field of Planetary Health going forward with my own skill set.”
	COVID-19	The impacts of COVID-19 and spillover events on planetary health.	“It is very difficult to feel confident about the state of our Planetary Health when the majority of my adult life so far has been filled with a global pandemic that could have been avoidable and was likely the fault of humans due to land-use. With that being said I feel that the impacts of COVID-19 have softened a lot of hearts and awakened a lot of minds to the crisis that we are enduring and the impacts of human consumption and expansion, so I feel good about the amount of people who are fighting for change.”	“The world is only just now recovering from a traumatic spillover event that took over the entire world, and it feels like society is slowly falling back into the same conditions that allowed for the pandemic.”

Table 3. Indirect assessment results: Areas of thematic difference—summer cohort. Each theme is defined based on responses from the summer cohort. Representative quotes illustrate the similarities among responses.

	Themes	Definition	Representative Quotes
Pre-Assessment	Impact of climate change on human health	The importance of acknowledging climate change impacts human health in multiple ways.	“It seems blatantly obvious to me that environmental problems, like climate change, have a huge negative impact on human health, yet there are many individuals who do not even believe in climate change. Yet even those who do believe in climate change do not connect it with human health at all, they are simply seen in two different boxes that have no effect on each other.”
	Society geared against climate reality	The feeling of living in a society with individuals that do not believe climate change to be a priority.	“Especially in today’s world, it seems almost as if we have given up on trying to save this planet and are instead looking to space for focusing efforts to save the future of humanity. While some of my friends and family and I are very conscious of the state of our Planetary Health, I know that the majority of people are not, which both saddens and scares me.”
	Corporate responsibility	Corporations play a role in how we interact with the planet and their influence can be good or bad, which students are cognizant of.	“With rising concerns about climate change and the ignorance of big corporations to address and solve these environmental issues, I am quite afraid of what the future holds in regards to a suitable place to live and breathe.”
Post-Assessment	Individual agency	There are small scale actions that each person can take to improve their own impact on climate change.	“I feel as though there are a lot of changes we can make that I hadn’t originally thought of before in terms of improving health.”
	Corporate interests	Corporations actively pursue capitalist ideology which is assisting climate change.	“Though fossil fuel usage and careless agricultural practices may be lucrative in the short term, in the long run, they will have both devastating environmental and economic effects.”

Table 3. *Cont.*

Themes	Definition	Representative Quotes
Generational impacts	The optimistic view that the future generation of leaders and people in power will have the knowledge and tools to continue to improve conditions derived from climate change.	“Like any other historical social movements, it will require a community of advocates to push for upstream changes, but I [am] optimistic about the progressive thinking of the younger generation.”

Table 4. Indirect assessment results: Areas of thematic difference—winter cohort. Each theme is defined based on responses from the winter cohort. Representative quotes illustrate the similarities among responses.

Themes	Definition	Representative Quotes	
Pre-Assessment	Decreased optimism and a sense of helplessness about the state of our planet.	Feelings of pessimism, uncertainty, frustration, and general feelings of doubt about the ability or willingness of others to help. This is exacerbated by feelings of individual helplessness and thoughts of society as a whole neglecting the issue of climate change.	“I think we’re on an irreversible path toward altering the climate and will suffer the destructive and devastating impacts for the rest of humanity’s tenure on Earth. But this is the future we’ll have, so all thoughts of hope aside, it’s best to learn what we’re facing.”
	The interrelatedness of disciplines in planetary health.	Planetary health consists of disciplines that include medicine (e.g., COVID-19), biology, and other fields.	“I’m also hopeful that we can intersect medical anthropology, the biomedical model, and public policy/global health to reach empathetic conclusions on how we can save our world.”
	Importance of knowledge for oneself and others.	Descriptions of knowledge as power, an enthusiasm to learn, and the importance of sharing that knowledge with others in an effort to mitigate what is occurring.	“There are a lot of people with personal interests in pushing any sort of narrative, and it is very valuable to gain an actual deep understanding into the topic of Planetary Health in an academic way so that I can actually speak about these issues with surety.”
Post-Assessment	Solutions exist, but engaging others to change behavior is difficult, particularly on the society level.	An acknowledgement that solutions to increasing the health of our planet exist, though a commitment from individuals and governments to follow through is lacking. This feeling is confounded by feelings that the planet is in imminent danger and it may be too late for some solutions.	“Every solution has some kind of logistical difficulty, some kind of downside or ramification down the line, but inaction is not an option because most situations with the planet are developing exponentially rather than linearly, and time is literally gold.”

Table 4. Cont.

Themes	Definition	Representative Quotes
Increased cautionary optimism with limited hope for the future.	Feelings of tempered optimism along with acknowledgement of small-scale changes that feel promising and the hope for more large-scale solutions.	“Now, after taking the course, I think I could describe myself as cautiously optimistic. There are many achievable solutions on the horizon for a variety of problems. Some of these solutions revolve around minimizing our footprint—reducing deforestation, reducing pollution—and those solutions address health issues beyond the emergence of disease. Those are the solutions I am least optimistic about because I expect a lot of political opposition to them.”
Importance of collaboration in creating and implementing solutions.	Collaboration and working together as individuals, governments, and other organizations and disciplines is important in identifying solutions that are realistic and sustainable. However, these do require tradeoffs, as implementing planetary health solutions can also be seen as declining economic prosperity.	“I still am hopeful in the possibility that coalitions and partnerships between cross-disciplinary organizations (e.g., government branches, scientific and public health branches, etc.) can collaborate and pour their resources together to properly account for all of these seeming obstacles and hindrances towards proper action.”

4. Discussion

Assessment of a new undergraduate course on planetary health indicates the potential for online asynchronous modalities to educate young people about grand challenges and bolster hope by teaching solutions and offering community—even virtually. Based on standard assessment, our new course, BIOL 1455 *Planetary Health: global environmental change and emerging infectious disease*, was successful. Student feedback was positive on course content and instruction, and learning objectives were fully met in both summer and winter session offerings. Open comments from students in formal course feedback revealed two common suggestions we agreed with and will implement in future offerings: (1) regular opportunities for Zoom drop-in hours with the instructors (arranged at various times to accommodate students in various time zones), and (2) spacing out of the three primary course projects to assist students with time management.

Given the success of students in the course at all levels, future offerings will allow enrollment of first year students and advanced high school students in Brown’s pre-college summer session program. Related to the expansion in enrollment level is a need to enroll more students overall in planetary health courses. We aspire to increase enrollment in future offerings of BIOL 1455 without changing the structure of the course, which has proven successful. Growth in enrollment will require additional teaching assistants, use of rubric-based peer-feedback on some writing assignments prior to final submission, shortened and more focused reflections (continuing to allow choice of modality: video, audio, written), and potential evolution of the three projects into shortened assignments.

The asynchronous offering of the course suits our university’s curricular needs and benefits students in terms of flexibility and accessibility, and so we have no plans to change modality. We are cognizant, however, of students’ desire to interact with the instructor and need for guidance structuring their learning when on their own time—two course attributes arguably more easily accomplished in synchronous/in-person courses. To address these two challenges in our asynchronous course we will offer more guidance in the course orientation on how to be successful in asynchronous learning and, as noted previously, offer regular opportunities to interact with the instructor on Zoom. The structure of the course is in line with studies showcasing the value of learning when students rely less on memory and note-taking skills and more on opportunities for interactive learning with

peers, low-stakes reflection to showcase new knowledge, and projects to practice deep and critical thinking [9]. We will ensure these attributes remain in BIOL 1455.

We were intrigued by the potential for the course to introduce students to new concepts and formalize their understanding of familiar ones. We offer two examples. First, we noted that students entering the course often thought primarily about climate change when reflecting on the state of the planet, but left the course with a broader appreciation of the myriad ways in which humans impact the environment:

“My main focus was originally on climate change prior to this course, but this course challenged me to think of ways in which improving animal trade conditions can also improve Planetary Health. For example, improved regulations of imported animals may lead to less likely cases of spillover. A decrease in land-use change could prevent deforestation and stop the reduction of biodiversity, which in turn supports human health. Another example was how better conditions and an overall decrease in factory farming could reduce spillover events as well.”—post assessment student response.

While climate change is arguably the most broadly impactful environmental change underway, it is certainly not the only one and it interacts quite frequently with others. The Planetary Health Alliance makes this point well, “*It is not just climate change; it is everything change! We face not only a disrupted climate system, but the 6th mass extinction of life on Earth; global scale pollution of air, water, and soil; shortages of arable land and freshwater; pervasive changes in land use and cover; and degradation of marine systems.*” Planetary Health addresses all of the ways in which humans impact natural systems and how these impacts influence human health. Courses teaching environmental change and human health have the opportunity to introduce students to the array of changes underway so that they are better informed of the full extent of human impact on the planet. This can be achieved using a planetary health approach.

Second, the course was successful in arming students with a formal understanding of concepts that they now engage with regularly in their lives. One example is the term emerging infectious disease—a concept familiar to anyone attentive to current events over the last three years. At the onset of the course, no student was able to correctly define “emerging infectious disease”, despite acknowledging that it was a very familiar term. By the end of the course, students scored significantly higher on their ability to formally define this now ubiquitous term (pre: $M = 83.6$, $SD = 95.8$; post: $M = 300$, $SD = 0$; $p < 0.001$).

Most compelling was the opportunity the course provided for students to engage on a topic of academic and personal importance. Student sentiment prior to engaging with BIOL 1455 indicated concern over lack of knowledge (but desire to learn), frustration with political barriers to bringing about political change, along with environmental-change-associated inequities. At pre-assessment, a plurality of students cited the politicization of climate change and record-breaking “tipping points” as a primary planetary health concern. At post-assessment, many student responses acknowledged gaining a broader understanding of planetary health issues, and possible solutions.

We perceived a shift in student sentiment from frustration and pessimism at the start of the course towards hope and optimism by the end of the course, particularly for the winter cohort. While many factors may account for differences in sentiment between cohorts, one intriguing effect may be current events during the time of enrollment. For example, the months of June–August 2022 (when our summer course is offered) brought record high temperatures to Europe, continued wildfire in California, and severe flooding in South Asia, Central Africa, and mid-western US states. Students exposed to such events, personally or via the news, while also engaging with related course material, may have experienced a higher state of eco-anxiety and pessimism for the future of the planet relative to those enrolled during months with fewer such incidents.

BIOL 1455 holds promise in continuing to educate undergraduate students about the new field of planetary health and environmental change–infectious disease linkages, and offering solutions and hope. Our study of two course cohorts was informative, yet we recognize some limitations. Immersion–crystallization is a useful application to better

understand student sentiment towards learning and content, and it was informative for us here. Two of the three researchers who engaged in the analyses were former students in the course and may have carried their own biases. Indeed, immersion–crystallization recognizes that researchers are biased, and may influence the subjective identification of patterns and themes. To mitigate this bias, we ensured one of the two qualitative coders for each cohort had no prior experience in the course.

5. Conclusions

Planetary health is gaining traction in the medical, graduate, and more recently, undergraduate curricula of institutions of higher learning. If education is a solution to grand challenges such as planetary health, higher learning will play a continued important role. Planetary health programs and course offerings are timely and align well with institutional efforts to address issues of justice, equity, diversity, and inclusion (JEDI). Indeed, planet-wide inequities are expected to increase as disadvantaged populations are disproportionately affected by environmental change [10,11]. Institutions of higher education may in fact benefit from uniting JEDI efforts with those simultaneously underway and aimed at addressing environmental change and sustainability. Related to this is an opportunity to position campus wellness and psychological services to consider and attend to eco- and climate-anxiety in their plans to support students. Ultimately, higher education is poised to integrate planetary health learning and response into various facets of work already underway. Low hanging fruit can include course offerings such as the one we describe here—accessible to students early and regardless of disciplinary interest. Scaling up such courses, when fully online and asynchronous, can bring planetary health education to all corners of higher education and potentially beyond.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/challe14030036/s1>, Course syllabus; pre/post assessment with standardized grading rubric.

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