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Perceptions of environmental health education among medical students: opportunities for improving the training of health professionals on planetary health issues – a cross-sectional survey in a French university

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Abstract

Background: Deteriorating environmental conditions directly affects human health and healthcare organization . Although environmental health education in initial medical training appears to be a key factor to implementing attenuation and adaptation strategies, it remains insufficiently integrated into medical curricula, and the views of students receiving such training are rarely documented. This study aims to identify the methods of integration and teaching deemed most relevant by medical students who completed a compulsory 31-hour module.

Methods: A descriptive, cross-sectional, survey study was conducted among third-year undergraduate medical students at a French university who had taken the 'Environmental Health' module in the 2024-2025 and 2025-2026 academic years. Students completed a 43-item questionnaire one year after the course for the 2024-2025 cohort, or immediately afterwards for the 2025-2026 cohort. Closed-ended responses were analyzed descriptively as counts and percentages ; no statistical testing was performed. Open-ended questions were analyzed narratively.

Results: A total of 140 questionnaires were analyzed, representing a final response rate of 37.3%. Among the respondents, 94 (67.1%) considered the cross-curricular integration of the course throughout the entire program to be more relevant than a standalone module. There were 96 (69.1%) who felt that 30 hours was too long, while 102 (72.9%) believed that all students should take this type of course. Immersion in other contexts (83.6%) and hands-on learning (74.3%) far outstripped theoretical instruction (22.9%) among the tools considered useful for raising awareness, while university courses were

ranked last among sources of awareness (28.6%). Finally, 114 students (81.4%) reported that their other teachers never or rarely addressed these issues.

Conclusions: Students who are among the most extensively trained in environmental health in France consider their course to be too long but believe that these issues should be taught to everyone, in a cross-disciplinary manner and through active learning formats. Training teachers in all disciplines appears to be a prerequisite for this change.

Keywords

Planetary health; environmental health education; medical curriculum; planetary boundaries; multidisciplinary study; cross-curricular integration

Background

Planetary health encompasses the health of human civilization and the state of the natural systems on which it depends. Humanity has entered a critical phase regarding its future and the maintenance of sustainable human health. Human health is part of the health of all living things and depends on stable environmental conditions, balanced ecosystems and material resources that enable society and healthcare systems to function [1].

The planetary boundaries framework proposes to quantify nine processes regulating the stability of the Earth system, and to define a safe operating space for humanity for each one [2, 3]. Exceeding these boundaries, due to human activity, destabilizes planetary systems and the environmental conditions essential for life and for the protection of populations [4]. According to the 2025 assessment, seven of these boundaries have been progressively exceeded over recent decades [5]. In 2024, the annual average temperature exceeded 1.5°C above pre-industrial levels for the first time, and 12 of the

20 health risk indicators tracked by the *Lancet Countdown* reached their highest levels ever recorded. Indeed, heat-related mortality has risen by 63% compared with the 1990s, reaching an average of 546,000 deaths per year between 2012 and 2021 [6]. The Intergovernmental Panel on Climate Change (IPCC) estimates that 3.3 to 3.6 billion people live in areas that are highly vulnerable to climate change [7], and the World Health Organization (WHO) projects an additional 250,000 deaths per year between 2030 and 2050 attributable solely to undernutrition, malaria, diarrhea and heat stress [8].

Healthcare professionals are directly affected. They will face changing patterns of morbidity and mortality and the need to adapt medical practices and the organization of care against a backdrop of increasing environmental, energy and material constraints. Healthcare systems will need to limit their own vulnerability, while nearly a billion people already depend on healthcare facilities without a reliable electricity supply [6], and the implementation of adaptation strategies is hampered by a lack of human, material and financial resources, at a time when demand for healthcare is growing [9]. The health sector is also itself a major source of greenhouse gas emissions: in France, its carbon footprint is estimated at around 49 million tons of CO_2 equivalent, representing more than 8% of the national footprint [10].

Planetary health became established as a field around a decade ago, while the *One Health* concept received a consensus definition in 2022 [11]. Healthcare professionals trained before this period did not receive specific, structured training on these approaches. Since then, the editors-in-chief of more than 200 medical journals have jointly issued two calls to action, in 2021 and again in 2023, in response to the climate and biodiversity crisis [12, 13].

Initial training therefore appears to be a key lever for change, and an international consensus has defined the expected competencies [14], a framework has been proposed by the students themselves [15, 16], universities have assessed the effectiveness of their teaching [17, 18], and medical student associations are calling for these measures to be implemented in all university programs [19, 20]. However, the global survey conducted for the *Lancet Countdown* between October 2024 and February 2025, covering 147 medical institutions in 46 countries, shows that 72% of them offered teaching on health and climate, reaching 64% of medical students, and that 62% made it compulsory: the authors conclude that this teaching remains insufficiently integrated into the curriculum and leaves many future professionals ill-equipped to deal with the risks associated with climate change [6].

In France, a national survey carried out in 2021 across 193 healthcare training institutions found that only 31% offered teaching on environmental issues, with these modules most often being optional and comprising few teaching hours, while 84% of the 3,384 students surveyed believed that climate issues should be taught during their studies, with 54% stating this should be compulsory [10]. In 2022, the Ministry of Higher Education set the target of training all students in their second year of higher education in the challenges of the ecological transition within five years, prioritizing the integration of these topics into existing courses [21]. The framework document published the following year sets out the details, including a core set of skills based on the European *GreenComp* framework [22], and a course of at least 30 hours leading to a certificate [23].

Courses delivered in healthcare vocational schools have been the subject of international studies [24, 25], but the perspectives of the students trained remain under-assessed and

do not cover multimodal teaching such as that in our study [17]. Gathering the views of students who have benefited from teaching on this scale is therefore of particular interest, as they are future doctors trained in environmental health, a field in which few of their practicing peers have received such training.

The main objective of this study is to identify the methods of integrating and teaching environmental health that these students consider most relevant. The secondary objectives relate to the acceptability of strengthening this teaching within the medical curriculum, the potential for extending it to all students, a comparison between cross-curricular integration and a dedicated module, the teaching formats and awareness-raising sources deemed most effective, as well as the module's impact on students' perceptions of their future profession as doctors.

Methods

Type of study

We conducted a descriptive, cross-sectional, quantitative survey study using a self-administered questionnaire among third-year undergraduate medical students at the University of Reunion Island who had taken the 'Environmental Health' module during the academic years 2024-2025 and 2025-2026.

Course evaluated

Since the start of the 2023-2024 academic year, the national 'Medicine and Environmental Health' course, in the form of a digital learning program hosted on the Université Numérique En Santé et Sport (UNESS) platform, led by Dr Marine Sarfati under the auspices of the Conference of Deans of French Medical Faculties, has been incorporated into the initial training of medical students. Within this syllabus, the

‘Environmental Health’ module was introduced in 2024 and made compulsory at the University of Reunion Island. It comprises 20 hours of online lectures and training, including the national digital course, 8 hours of lectures and tutorials, and 3 hours of practical sessions, comprising the Health Transition Fresk workshop [26] . The entire module is delivered over one semester. It accounts for approximately 31 hours and is subject to assessment. To pass this course module , students must complete the entire online course and achieve an average mark of more than ten out of twenty. This mark comprises an oral presentation and a poster presentation, which counts towards continuous assessment with a weighting of 1, and a final multiple-choice test , with a weighting of 2. The marks contribute to the ranking that determines the allocation of clinical placements.

Study population and data collection

The two cohorts who undertook the course were contacted by two different means: by email for the 2024-2025 cohort, nearly a year after the course, and in person at the end of the final session of the course for the 2025-2026 cohort.

In total, 375 students were contacted and 147 questionnaires were received between 14 August and 26 November 2025. Seven were excluded: 4 because the respondents stated they had not taken the module, 1 was blank , 1 in -person completed questionnaire contained no answers, and finally, another questionnaire contained a free-text response that had characteristics identical to another, suggesting that the respondent had participated twice, thus only the first submission was retained. A total of 140 questionnaires were analyzed, representing a response rate of 37.3% (Fig. 1). All included respondents stating that they had attended the course. All students enrolled

in the module in the two cohorts were invited, and no sampling was performed. No a priori sample size calculation was performed, as the survey was addressed to the whole eligible population.

Fig. 1 *Study flowchart. Response rates are expressed as a proportion of the number of students approached in each year group. The final response rate is expressed as a proportion of the 375 students approached*

Questionnaire

The questionnaire was created using Google Forms by the first author in consultation with the module coordinators. In its final version, it comprised 43 questions, including 41 closed-ended questions (single or multiple choice) and two open-ended questions, divided into seven sections: student profile, assessment of teaching, awareness of environmental issues, personal impact of the module, integration into medical training, opinions and recommendations, and prospects and teaching tools. Responses were not mandatory. Four closed-ended questions included an 'Other' option allowing for a short, free-form response. The questionnaire was not subject to psychometric validation or a formalized pre-test. The full questionnaire is provided in the supplementary file (Additional file 1).

Outcome measures

The primary outcome measure was the proportion of students who considered the cross-curricular integration of the teaching across all modules of the program to be more relevant than a standalone module. The secondary outcome measures focused on the acceptability of strengthening this teaching, its extension to all students, the teaching formats and awareness-raising resources deemed most effective, the number of teaching

hours considered appropriate for untrained professionals, and the module's impact on students' perceptions of their future career as doctors.

Analysis

The responses to the closed-ended questions were analyzed descriptively and are expressed as absolute values and percentages. The figures and proportions correspond to the counts generated by the online form, relative to the number of respondents to each question. Missing data related to eight questions and concerned a single respondent in each case. There was no difference in the courses delivered during the two years. No comparisons were made between the two cohorts, nor were any statistical tests carried out. The data were exported and processed using Microsoft Excel spreadsheet. The results are presented according to a thematic grouping of the questions, which differs from the order in which they were asked: this allows the questions to be grouped around the primary outcome measure and the secondary outcome measures. The two open-ended questions, which received responses from 73 (%) and 52 (%) students respectively, were summarized narratively to identify the main ideas expressed, without formal coding. This study is reported in accordance with the STROBE statement for cross-sectional studies [27] and the CROSS checklist for survey studies [28]. Free-text responses were collected in French, the quotations reported in this article were translated into English by the authors. DeepL was used to translate the manuscript into English then this translation was reviewed and minor modifications were made to ensure accurate translation.

Anonymity and data confidentiality

The questionnaire's home page outlined the purpose of the survey, its approximate duration and the anonymous nature of the responses. Participation was voluntary and constituted consent. No sensitive or health-related data were collected. The data were processed in an anonymized manner, in accordance with the General Data Protection Regulation (GDPR).

Results

Sample characteristics

A total of 140 questionnaires were analyzed: 30 (21.4%) completed via emails, and 110 (78.6%) in person. Respondents were on average 21.5 years old, with a median age of 21 and a range from 18 to 36 years. The sample comprised 97 women (69.3%), 41 men (29.3%), and 2 who did not specify their gender. Regarding year of study, 110 were in their third year (78.6%) and 30 in their fourth (21.4%), who were all in the email group. Before taking the 'Environmental Health' module, 88 of them (62.9%) declared being unfamiliar with the planetary boundaries framework (Table 1).

Table 1 *Characteristics of respondents (n = 140)*

Characteristics	**n (%)**
Women	97 (69.3)
Men	41 (29.3)
Not specified	2 (1.4)
Third year	110 (78.6)
Fourth year	30 (21.4)
Unfamiliar with the planetary boundaries framework before the module	88 (62.9)

Place of teaching within the curriculum

Among the respondents, 94 (67.1%) considered it more appropriate to integrate the subject across all modules of the program, compared with 46 (32.9%) who favored

220 a dedicated module (Table 2). No data was missing for this question. 92 students
221 (66.2%, n = 139) believed that environmental issues should be integrated more fully
222 into medical training; 16 (11.5%) disagreed, and 31 (22.3%) had no opinion. In total, 102
223 students (72.9%) considered that all students should undertake this type of teaching, 14
224 (10.0%) disagreed, and 24 (17.1%) had no opinion. A total of 74 students (52.9%)
225 perceived a significant gap between this module and the rest of their training, compared
226 with 49 (35.0%) who considered it to be fairly consistent. Furthermore, 114 (81.4%)
227 reported that their other teachers never or rarely addressed environmental issues in their
228 lectures, and 83 (59.3%) felt that teachers were not sufficiently trained on these topics.

Table 2 *The role of teaching in the curriculum*

Method of integrating teaching deemed most relevant (n = 140)	**n (%)**
Integration across all modules	94 (67.1)
A standalone module	46 (32.9)
The need to integrate environmental issues into medical training (n = 139)	
Yes	92 (66.2)
No opinion	31 (22.3)
No	16 (11.5)
Value of making this type of teaching compulsory for all students (n = 140)	
Yes	102 (72.9)
Don't know	24 (17.1)
No	14 (10.0)
Perceived discrepancy between the module and the rest of the course (n = 140)	
Yes, to a large extent	74 (52.9)
No, it's fairly consistent	49 (35.0)
Don't know	17 (12.1)
Environmental issues mentioned by other teachers (n = 140)	
Rarely	76 (54.3)
Never	38 (27.1)
Yes, sometimes	20 (14.3)
Yes, often	6 (4.3)
Sufficient training of other teachers on these topics (n = 140)	
No	83 (59.3)
Don't know	46 (32.9)
Yes	11 (7.9)

Assessment of the module

When asked about the current number of teaching hours, 96 (69.1%) felt that 30 hours was too long, 39 (28.1%) considered it sufficient, and only one felt it was insufficient (Table 3). The teaching was deemed pedagogically relevant by 79 respondents (56.8%), clear and well understood by 70 (50.4%), and applicable to future practice by 45

(32.4%). For 23 respondents (16.5%), these lessons were of little use to their practice, and 18 (12.9%) found them incomplete or unclear.

Table 3 *Results of the questions relating to the assessment of the module*

Assessment of the duration (30 hours) of teaching (n = 139)	**n (%)**
Too long	96 (69.1)
Sufficient	39 (28.1)
No opinion	3 (2.2)
Insufficient	1 (0.7)
Perceived quality of teaching (n = 139, multiple responses)	
Pedagogically relevant	79 (56.8)
Clear and well-explained	70 (50.4)
Applicable to future practice	45 (32.4)
Of little use in practice	23 (16.5)
Incomplete or vague	18 (12.9)

Impact of the module on students

The module changed the outlook of 57 students (40.7%) on the world and changed it only slightly for a further 65 (46.4%) (Table 4). In total, 99 students (70.7%) stated that the module had slightly altered their view of their future career as a doctor, 22 (15.7%) said it had altered it significantly, and 19 (13.6%) said it had not altered it at all. Among the respondents, 96 (68.6%) had already considered that their future career might have a negative environmental impact. The module had an effect on the personal lives of 51 students (36.4%) and changed the career plans of 11 (7.9%) of them.

The feelings most frequently evoked by the module were a drive to take action (50, 36.0%), fear (38, 27.3%), low mood (30, 21.6%), a keen interest motivating them to explore the subject further (29, 20.9%) and outrage (23, 16.5%). Finally, 31 (22.3%) students reported none of these effects.

252 ***Table 4*** *Impact of the module on students*

Change in relationship with the world (n = 140)	**n (%)**
Yes	57 (40.7)
Slight	65 (46.4)
No	18 (12.9)
Change in outlook regarding future career (n = 140)	
A little	99 (70.7)
A lot	22 (15.7)
Not at all	19 (13.6)
Believed that their future career might have a negative environmental impact (n = 140)	
Yes	96 (68.6)
No, never	35 (25.0)
Don't know	9 (6.4)
Impact on personal life (n = 140)	
Yes	51 (36.4)
No	89 (63.6)
Change in career plans (n = 140)	
Yes	11 (7.9)
No	129 (92.1)
Feelings evoked by the module (n = 139, multiple responses)	
A driving force to take action	50 (36.0)
Fear	38 (27.3)
None of the above	31 (22.3)
Feeling down	30 (21.6)
A keen interest motivating further study	29 (20.9)
Outrage	23 (16.5)
Another strong feeling	12 (8.6)
Discussions about the module with friends and family (n = 139)	
Yes, if the subject is brought up	79 (56.8)
No, it's not a priority for them	35 (25.2)
No, doesn't know how to talk about it	15 (10.8)
Yes, regularly	10 (7.2)

253

254 **Perception of environmental issues**

255 In total, 106 students (75.7%) considered the issue of planetary boundaries to be a major

256 concern for human health, 56 (40.0%) felt that it was downplayed by healthcare

257 professionals, and, conversely, no one considered it to be exaggerated (Table 5). A total
258 of 93 students (66.4%) considered themselves eco-conscious and 21 (15.0%) eco-
259 anxious.
260 Some, or most, current medical practices, were considered to be harmful to
261 human health due to their environmental impact by 97 (69.3%) and 31 (22.1%)
262 respondents, respectively. While 67 (47.9%) believed that practices within their field
263 had changed or were ready to change in response to these challenges.
264 When asked to provide examples of situations in medicine that conflicted with
265 environmental concerns, 34 replied in the affirmative (24.5%), and 29 (20.9%) cited
266 specific examples. These were grouped into five categories (Table 6), relating mainly
267 to single-use equipment and hospital waste, hygiene and sterilization, and prescriptions
268 or tests deemed excessive.

269 ***Table 5*** *Perception of environmental issues*

Degree to which planetary boundaries pose a challenge to human health (n = 140, multiple responses)	**n (%)**
The issue is major	106 (75.7)
The issue is downplayed by healthcare professionals	56 (40.0)
The issue is fairly significant	34 (24.3)
The issue is rather minor	1 (0.7)
No opinion	1 (0.7)
The issue is being exaggerated by healthcare professionals	0 (0.0)
Students' self-perception (n = 140, multiple responses)	
Environmentally conscious	93 (66.4)
Neither	26 (18.6)
Environmentally anxious	21 (15.0)
Don't know	10 (7.1)
Groups that have fully embraced the planetary boundaries paradigm (n = 139, multiple responses)	
Scientists	91 (65.5)
Students	36 (25.9)
None of the groups listed	25 (18.0)
Doctors	20 (14.4)
Don't know	19 (13.7)
Politicians	6 (4.3)
Patients	4 (2.9)
People from Reunion Island in general	4 (2.9)
Belief that current medical practices are harmful due to their environmental impact (n = 140)	
Yes, certain practices	97 (69.3)
Yes, most current practices	31 (22.1)
Yes, few practices	10 (7.1)
No	2 (1.4)
Perception that practices in the sector have changed or are ready to change (n = 140)	
Yes	67 (47.9)
Don't know	38 (27.1)
No	35 (25.0)
Recognition of medical courses or situations that conflict with environmental issues (n = 139)*	
No	105 (75.5)
Yes	34 (24.5)

**Five respondents did not tick 'yes' but provided an example in the open-ended field; their responses were therefore classified as 'yes'*

Table 6 *Thematic grouping of the examples of contradictions cited (n = 29)*

Topic	n (%)	Examples cited
Single-use items, packaging and waste	14 (48.3)	Shift from sterilizable to disposable items, multiple packaging of medical devices, single-use gloves, infectious medical waste, lack of waste sorting and recycling, non-reusable equipment in the emergency department, anti-bedsore mattresses
Hygiene and steriliz ation	9 (31.0)	Hygiene training courses, hygiene procedures during clinical placements, sterilization of medical devices, re-cleaning of unused equipment in the operating theatre
Excessive prescriptions, tests and procedures	8 (27.6)	Laboratory tests, unnecessary imaging, polypharmacy, expecting a prescription at every consultation
Food waste	2 (6.9)	Hospital catering
General responses	3 (10.3)	'Every action causes pollution', pollution of the healthcare system as a whole, birth rates and the distribution of wealth

A single response could cite several examples; the total number of responses exceeds 29

Expected role of healthcare professionals and scientists

For 81 respondents (57.9%), the medical profession shows concern and bares responsibility for environmental issues, while 86 (61.4%) did not believe that healthcare professionals are better educated than the general public on planetary health (Table 7). The actions of older peers were deemed unsatisfactory by 80 students (57.1%), and 85 (61.2%) expressed rather negative feelings towards previous generations. In total, 56 (40.0%) felt that teachers, healthcare professionals and scientists are not fulfilling their responsibilities, while 57 (40.7%) did not express an opinion. When asked which groups they trusted to protect health and the environment, 61 students (43.6%) did not name any, 46 (32.9%) named the teaching staff, and 30 (21.4%) named the medical profession. For 108 (77.1%), scientists and healthcare professionals were well placed to steer

societies towards greater respect for planetary boundaries, and 103 (73.6%) wanted them to make a public commitment. Finally, 38 (27.1%) considered planetary health to be more important than the individual health of patients.

289 ***Table 7*** *Expected roles of healthcare professionals and scientists*

View that the medical profession bears particular responsibility and is particularly concerned (n = 140)	**n (%)**
Yes	81 (57.9)
No	40 (28.6)
Don't know	19 (13.6)
Belief that healthcare professionals are better trained than the general public (n = 140)	
No	86 (61.4)
Don't know	32 (22.9)
Yes	22 (15.7)
Assessment of the performance of senior peers (n = 140)	
Somewhat unsatisfactory	57 (40.7)
Don't know	34 (24.3)
Very unsatisfactory	23 (16.4)
Somewhat satisfactory	21 (15.0)
Very satisfactory	5 (3.6)
Views on the actions of previous generations (n = 139)	
Rather negative	85 (61.2)
Neutral	39 (28.1)
Rather positive	9 (6.5)
Don't know	6 (4.3)
Feeling that teachers, healthcare professionals and scientists are taking their responsibilities seriously (n = 140)	
Don't know	57 (40.7)
No	56 (40.0)
Yes	27 (19.3)
Groups the student trusts to protect health and the environment (n = 140, multiple responses)	
None	61 (43.6)
Teaching staff	46 (32.9)
The medical profession	30 (21.4)
Society	24 (17.1)
Don't know	18 (12.9)
View that scientists and healthcare professionals are well placed to bring about social change (n = 140)	
Yes	108 (77.1)
No	17 (12.1)
Don't know	15 (10.7)
Belief that they should make a public commitment (n = 140)	
Yes	103 (73.6)
Don't know	25 (17.9)
No	12 (8.6)
Belief that planetary health is more important than the individual health of patients (n = 140)	
No	59 (42.1)
Don't know	43 (30.7)
Yes	38 (27.1)

Teaching methods and awareness-raising resources

The teaching methods considered most effective were video materials (82 responses, 58.6%), educational games (78, 55.7%) and practical work (65, 46.4%), far ahead of lectures (21, 15.0%) (Table 8).

Among the tools likely to raise awareness and prompt action , immersion in other contexts came top (117, 83.6%), followed by practical teaching (104, 74.3%), artistic tools (76, 54.3%) and supervised reflection time (74, 52.9%). Theoretical teaching was selected by 32 students (22.9%). More specifically, 133 students (95.0%) felt that raising awareness should be achieved through means other than theoretical knowledge. For 102 (72.9%) students, the Climate Fresk alone was not sufficient to raise awareness.

When asked about the sources of awareness they considered most effective , respondents ranked the media (104, 74.3%), social media (98, 70.0%), personal experience (90, 64.3%) and discussions with teachers, healthcare professionals or peers (85, 60.7%). University courses came last (40, 28.6%).

The most frequently cited number of compulsory training hours deemed appropriate for untrained professionals was 20 hours (55 , 39.3%), followed by 10 hours (50, 35.7%) and 40 hours (14, 10.0%). Eight students (5.7%) did not consider any training necessary.

307 ***Table 8*** *Teaching methods and sources of awareness-raising considered most effective*

Teaching methods considered most effective (n = 140, multiple responses)	**n (%)**
Video materials	82 (58.6)
Educational games	78 (55.7)
Practical work	65 (46.4)
Lectures	21 (15.0)
Tools that raise awareness and encourage action (n = 140, multiple responses)	
Immersion in other contexts	117 (83.6)
Practical teaching	104 (74.3)
Artistic tools	76 (54.3)
Supervised reflection time	74 (52.9)
Theoretical teaching	32 (22.9)
Research and bibliography	13 (9.3)
Sources of awareness considered most effective (n = 140, multiple responses)	
Media	104 (74.3)
Social media	98 (70.0)
Personal experience	90 (64.3)
Discussions with teachers, healthcare professionals or peers	85 (60.7)
University courses	40 (28.6)
Belief that awareness-raising should be achieved through means other than theoretical knowledge (n = 140)	
Yes	133 (95.0)
Don't know	5 (3.6)
No	2 (1.4)
Ideal number of compulsory training hours for untrained professionals (n = 140)	
20 hours	55 (39.3)
10 hours	50 (35.7)
40 hours	14 (10.0)
None	8 (5.7)
100 hours	3 (2.1)
60 hours	2 (1.4)
Other open-ended responses	8 (5.7)
View that the Climate Fresk is sufficient to raise awareness (n = 140)	
Yes	21 (15.0)
Don't know	17 (12.1)
No	102 (72.9)

308

309 **Open-ended responses**

310 The two open-ended questions received 73 and 52 responses respectively.

The first question asked students what had made the greatest impression on them during the module. The planetary boundaries model and the exceeding of these boundaries was the most frequently cited response, appearing in 13 answers. The Climate Fresk also made an impression on students, who mentioned it in 9 answers. Oral presentations were mentioned 8 times, as were the videos and the questions that followed them. The final theme that clearly emerged was the environmental footprint of the healthcare system, mentioned on 6 occasions. Several responses (n = 6) highlighted an aspect of the module itself, such as 'the length of the module' or the fact that it was 'COMPULSORY'. Other responses not classified into a category included 'the number of diseases caused by pollution', 'the overconsumption of raw materials' and 'the urgent need to change our behavior'. All the open-ended responses to question 42 are available in the supplementary file (Additional file 2).

The second open-ended question invited students to submit their suggestions or comments. Among the responses, 15 were blank or negative. The most frequent comment (n = 14) concerned the module being scheduled in a semester that counts towards the ranking determining clinical placement allocation. Other comments and suggestions related to the length of the module and the amount of information (n = 12), teaching methods (n = 8) and online videos (n = 4). Some students shared their positive views on the course (n = 7), while two others suggested extending the course to healthcare professionals. All open-ended responses to question 43 are available in the supplementary file (Additional file 3).

Discussion

Key findings

In our study, more than two in three students considered it appropriate to integrate 'Environmental Health' teaching across the entire curriculum rather than as a standalone module. Nearly seven in ten students felt that 30 hours of training was too long, while nearly three-quarters believed that all students should undertake this type of teaching. These results highlight a demand that relates as much to the format of the teaching as to its volume . Whilst this teaching appears essential, its volume must be carefully managed, and it must be integrated coherently throughout the entire curriculum. The open-ended responses point in the same direction: criticism is directed almost exclusively at the delivery methods of the program , and not at the subject matter itself.

A subject taught infrequently but considered too long

The national survey conducted by the *Shift Project* in 2021 across 193 health education institutions showed that only 31% offered teaching on environmental issues. These courses were predominantly optional and involved few teaching hours, while 84% of the students surveyed believed that these issues should be taught [10]. In a German national survey of the country's 39 medical faculties [29], teaching on planetary health was mainly optional, and compulsory teaching amounted to a median of 2 units of 45 minutes, limiting its integration into the curriculum and the in-depth study of complex topics. In our study, the module is compulsory and assessed, and comprises approximately 31 hours; it is therefore considerably more extensive than the German median compulsory workload. The students surveyed in our study, 69.1% of whom find this teaching too long, are therefore among the most extensively trained in the countries where comparable national surveys are available. Our students are not expressing a lack of interest in the

subject, but rather criticizing the way in which this program is organized. One respondent expressed this ambivalence: *'This course was very interesting and enriching, but placing it in a semester that counts towards our ranking demotivates most of us.'*

A demand for training but a feeling of being overburdened

Students' interest in incorporating a module on environmental health into the medical curriculum is well documented [30–32]. However, there is a tension between this demand and the perception that the curriculum is already overloaded. In a survey conducted in an American university , out of 280 students (medicine, nursing and physician assistants), 62.8% felt that the subject should be covered in lectures and reinforced during clinical placements. Nearly 30% stated that they did not have time to learn about it, as their training and exams already demanded their full attention [30]. An Italian study involving 638 students and residents found a similar proportion (25.6%) who considered their training workload already too heavy to tackle these topics [31]. In a national survey conducted in China among 1,387 medical students, 79.8% were in favour of integrating climate change into medical training [32]. Another review combining 21 international studies and involving 9,205 health students concluded that coverage of this subject is insufficient [33]. The *Shift Project* identifies the intensive and demanding nature of these degree programs as a barrier, as well as the lack of academic staff trained in environmental health [10]. Our work documents this ambivalence among students exposed to such teaching and highlights the need to adapt it to the requirements of the medical curriculum.

A stand-alone module or cross-curricular integration?

In our study, over half of students perceived a significant gap between this module and the rest of their course, and 81.4% reported that their other teachers never or rarely addressed these issues. Furthermore, 67.1% considered cross-curricular integration into the medical curriculum to be more relevant. This preference is consistent with the findings of a German study involving 170 medical students, in which the integration of climate issues into existing compulsory modules was significantly preferred over separate compulsory courses [34]. Our respondents, however, had already completed the course. A systematic review of published learning objectives on the health effects of climate change shows that this teaching remains largely theoretical, with only 30% falling within the 'application' level according to Bloom's taxonomy [35]. The authors' proposal aligns with our findings: linking climate change to biomedical mechanisms would allow it to be integrated into the traditional approach of medical curricula, focused on physiology, pathology and pharmacology, thereby minimiz ing the impact on already demanding programs [35].

Theoretical teaching is not the most popular

This study provides insights into teaching formats. The students we surveyed ranked university lectures last among the most effective sources of awareness-raising. The media, social media, personal experience and discussions with teachers, healthcare professionals or peers topped the list. These findings are consistent with a survey of 837 Jordanian healthcare students, which identified the internet and social media as the main sources of information on climate change for 88.9% and 86.5% of respondents respectively [36]. A survey conducted by French medical students found that those who reported having knowledge of environmental health had acquired it mainly through social

media [37]. This finding is embarrassing for the academic institution, but consistent with the other responses. Immersion in other healthcare settings and practical teaching were rated far more highly than theoretical teaching among the tools considered useful for raising awareness. Furthermore, 95% of respondents believed that raising awareness should be achieved through means other than theoretical knowledge. The Italian survey cited earlier reflects this expectation, with 84.3% wanting the content to be taught in lectures and reinforced during placements [31]. In our study, the practical teaching centred on the Climate Fresk made a strong impression on the students (spontaneously cited by 9 answers as one of the most memorable aspects of the module), but was deemed insufficient on its own to raise awareness. One open-ended response contrasted the two formats in a single sentence: *'I didn't like the e-learning; of course, you need to keep yourself informed, but it was rather boring to do on your own (…) ; the Climate Fresk was interesting, and debates would be interesting too.'*

The value of broadening education beyond medical studies

The scope of this training extends beyond medical studies. Nearly three-quarters of the respondents believed that all students should undertake this type of training, and two open-ended responses suggested that it should be extended to healthcare professionals, particularly as part of continuing professional development: *'This module should be retained in the university curriculum and extended even to healthcare professionals as part of continuing professional development.'* This comment echoes that of practicing healthcare workers, with a study conducted among 4,552 healthcare workers from six French hospitals identifying a lack of access to training as one of the main barriers to engagement in sustainability initiatives in support of the environment [38].

The number of teaching hours

We asked our students what the appropriate number of teaching hours would be for untrained professionals, and three-quarters of the responses fell between 10 and 20 hours. This is less than the 30 hours recommended by the national framework document for undergraduate students in higher education [23], and, crucially, nearly seven out of ten students felt that 30 hours was too long .

The expected role of healthcare professionals and scientists

While the majority did not believe that healthcare professionals were better informed than the general public on planetary health, they considered the medical profession to bear a particular responsibility, felt that scientists and healthcare professionals were well placed to bring about social change, and wanted them to make a public commitment. Another study found that 77 % of students believed that healthcare professionals have an important role to play in informing patients and the public [30]. An international survey of 9,220 scientists across 115 countries reports that half of them believe researchers should be more involved in advocacy, that only 29% are currently doing so, and that 23% have already taken part in a lawful demonstration [39]. Other authors argue that scientists have immense untapped potential to accelerate progress, and detail the ways in which they can get involved [40]. This expectation contrasts with the dissatisfaction felt towards older peers and the low level of trust placed in institutions to protect health and the environment: 57.1% of our respondents considered the actions of older professionals to be unsatisfactory, and 43.6% did not trust any group to protect health and the environment. The trust placed in the role of healthcare professionals does not appear to be a continuation of an existing model but rather relates to what this role could become.

Strategically positioning the module within the curriculum

One final finding from the open-ended questions deserves attention: of the 52 open-ended responses collected for the last question, 14 explicitly mentioned the fact that the module is scheduled in a semester that counts towards the ranking. One respondent wrote: *'Assessment takes precedence over meaning, and most of us end up learning the content superficially, just before the multiple-choice tests, without any real, lasting grasp of the knowledge.*' Another response explained the mechanism and suggests: *'Move the module to the second semester of the third year [where marks are not used for ranking purpose], because, due to the grading system for our clinical placements and the low weighting of the teaching unit, this is not at all our priority given all the other subjects we already have to study.*' A third student linked the duration to the format: '*It's too long; we have medical lectures and placements on top of that (…). Alternatively, this module should be integrated across the whole six-year program , or practical training should be delivered through immersion*.' The volume of teaching is therefore not the only issue: scheduling a substantial module with a low weighting in a high-stakes semester results in teaching that students neglect, and which would benefit from being integrated throughout the course in a cross-curricular or immersive manner.

Strengths and limitations

The main strength of this study lies in its sample: a large cohort of students who were exposed to a course, and who were surveyed about a program they had experienced first-hand.

Our study has several limitations. Although the survey covered a large proportion of the two cohorts concerned, with a high response rate for the face-to-face survey, the email survey conducted nearly a year after the course yielded only 16.8% of responses, compared with 67.1% for the face-to-face survey, which introduces a selection bias. Moreover, the method of data collection, the cohort, the year of study and the time elapsed since the module were entirely confounded: the 30 respondents contacted by email were all students from the 2024-2025 cohort, who were then in their fourth year. No comparison between the two groups was therefore carried out. The single- center nature of the study, focusing on a local scheme, limits the scope of these results. The questionnaire developed for the study was not validated or pre-tested, and certain phrasing may have influenced respondents' choices. Finally, social desirability bias cannot be ruled out on this highly delicate topic.

Conclusions

We surveyed medical students who had undertaken environmental health teaching to gather their views on the teaching methods they consider most relevant. They are in favour of a broader expansion and better integration of this teaching into the medical curriculum. The majority felt that the current volume of teaching was excessive, and active and immersive formats were overwhelmingly preferred to theoretical teaching. These results argue in favour of integrating environmental issues across other modules within the curriculum rather than concentrating them in a dedicated module; for more teaching in the form of scenario-based exercises; and for a framework for integrating this teaching that takes into account the overall assessment context for students: placing a substantial module with a low weighting in a semester that counts towards the ranking compromises

493 learning. Most respondents consider teachers in other disciplines to be inadequately
494 prepared and report that they almost never address environmental issues. Training for all
495 teachers therefore appears to be an essential prerequisite for the necessary development
496 of this teaching.

497 **List of abbreviations**

498 CO_2 Carbon dioxide

499 GDPR General Data Protection Regulation

500 IPCC Intergovernmental Panel on Climate Change

501 MCQ Multiple-choice question

502 STROBE Strengthening the Reporting of Observational Studies in Epidemiology

503 UNESS Université Numérique En Santé et Sport, the French national digital platform for
504 health and sport education

505 WHO World Health Organization

506 **Declarations**

507 **Ethics approval and consent to participate**

508 This study evaluated medical students' perceptions of a health and environment
509 teaching module through an anonymous questionnaire. Its purpose was educational
510 evaluation rather than the development of biological or medical knowledge within the
511 meaning of Article R.1121-1 of the French Public Health Code. Accordingly, the study
512 fell outside the scope of French regulations governing research involving the human
513 person, and approval from a Comité de protection des personnes (CPP) was not
514 required. The study was not submitted to a research ethics committee. Students were
515 informed of the purpose of the study, the use of their responses for research, and the

516 voluntary and anonymous nature of participation. They were informed that completing
517 and submitting the questionnaire constituted consent to participate.

518 **Consent for publication**

519 Not applicable.

520 **Availability of data and materials**

521 The datasets used and/or analyzed during the current study are available from the
522 corresponding author upon reasonable request.

523 **Competing interests**

524 BA, SD and CL were involved in the design and delivery of the teaching module evaluated
525 in this study. The authors declare no financial competing interests.

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528 **Authors' contributions**

529 VG devised the questionnaire, analyzed and interpreted the questionnaire data, and
530 wrote the first draft of the manuscript.

531 BL conceptualized the study, supervised and directed VG's work.

532 BA coordinated and administered the questionnaire to the students.

533 SD contributed to the development and design of the questionnaire.

534 CL contributed to the development and design of the questionnaire.

All authors read and approved the final manuscript.

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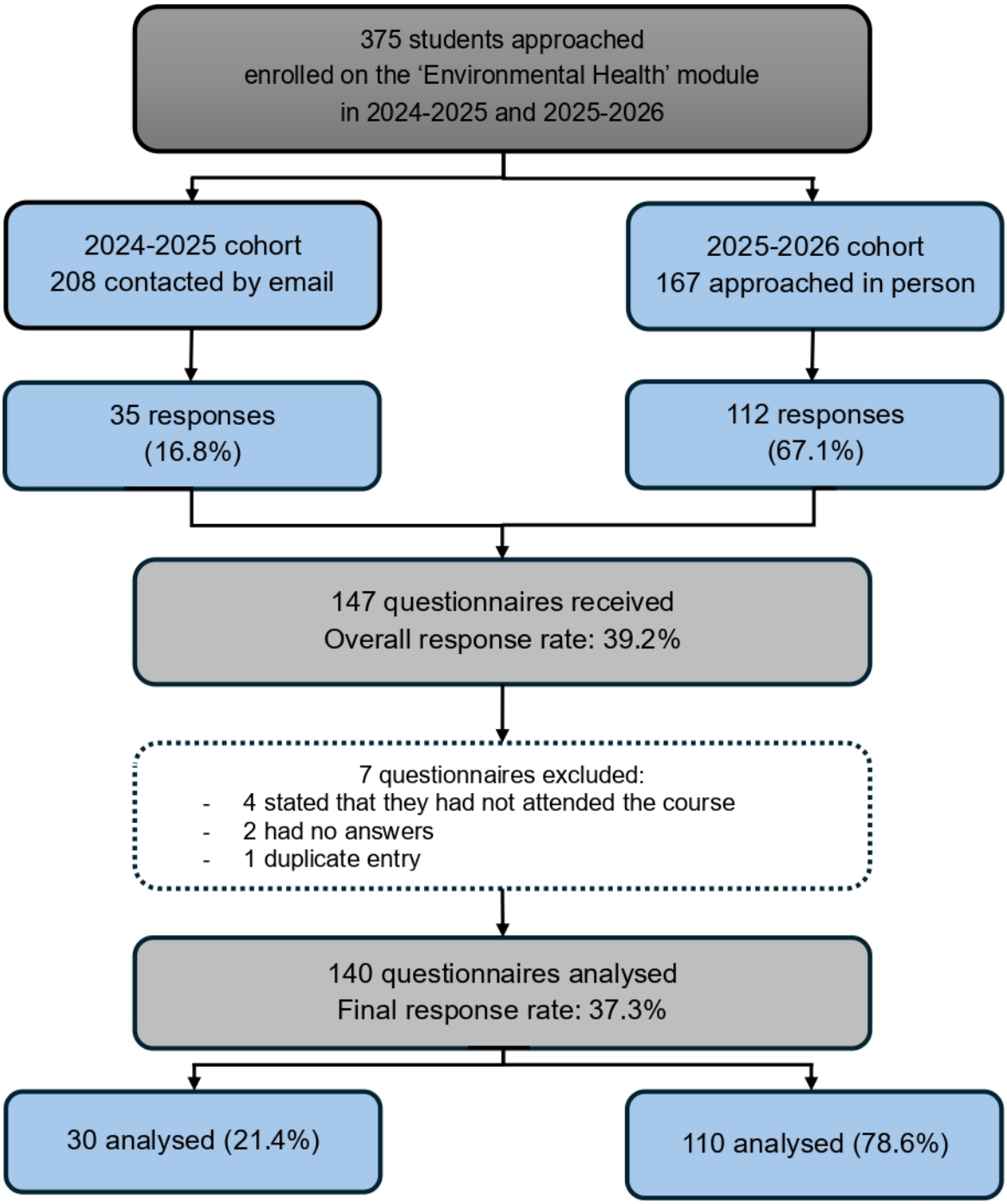
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686


375 students approached
enrolled on the 'Environmental Health' module
in 2024-2025 and 2025-2026
2024-2025 cohort
208 contacted by email
2025-2026 cohort
167 approached in person
35 responses
(16.8%)
112 responses
(67.1%)
147 questionnaires received
Overall response rate: 39.2%
7 questionnaires excluded:
- 4 stated that they had not attended the course
- 2 had no answers
- 1 duplicate entry
140 questionnaires analysed
Final response rate: 37.3%
30 analysed (21.4%)
110 analysed (78.6%)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1Translatedquestionnaire.docx
- Additionalfile3Q43freeanswers.docx
- Additionalfile2Q42freeanswers.docx