



Pharmacy students' perceptions on environmental sustainability in pharmacy education and practice

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ABSTRACT

Background: Given the negative environmental impacts of pharmaceuticals, including their contribution to healthcare's carbon footprint, pharmacists have a role in responding to the climate and biodiversity crises. Knowledge and education are required to support transitions to environmentally sustainable pharmacy practice (ESPP). The aim of this study was to explore Australian undergraduate pharmacy students' knowledge and attitudes towards environmental sustainability and ESPP curriculum content.

Methods: Participants were surveyed using an anonymous online questionnaire deployed using Qualtrics. The questionnaire comprised of two main sections: the 15-item New Ecological Paradigm (NEP) scale to determine participants' environmental attitude score, and section on students' perceptions and curricular experience of environmentally sustainable practice which was adapted from previously published surveys. The invitation with survey link was disseminated via social media, Australian pharmacy student organisations, and direct approach. Quantitative data were reported descriptively. Qualitative data from responses to open-ended questions were analysed thematically using a reflexive, recursive approach. Incomplete survey responses were excluded from the analysis.

Results: Of the 164 complete responses, 99% had previously received information on environmental sustainability. However, only 10% were knowledgeable about ESPP and only 8.5% were aware of ESPP content in their pharmacy school curriculum. Importantly, 70% of respondents saw ESPP as relevant to their future pharmacy practice, and 94% believed the pharmacy profession has a responsibility to undertake sustainability initiatives in the delivery of pharmaceutical care.

Conclusions: Australian pharmacy students lacked knowledge of ESPP and few reported having curricular exposure to ESPP content in their pharmacy degrees. Therefore, ESPP content is an important area for development in pharmacy curricula.

1. Introduction

As the climate and biodiversity crises worsen, health professionals are increasingly faced with the resulting health impacts, including illness caused by extreme heat events, increased transmission of infectious diseases, and trauma due to natural disasters.¹⁻⁴ Compounding these challenges, extreme weather events can disrupt healthcare delivery.⁵ Paradoxically, healthcare institutions generate large amounts of waste and greenhouse gas emissions (GHG_e), contributing to the climate crisis.⁶ Due to this complex interplay between climate change and healthcare provision, the response of the healthcare sector is an essential

part of climate change mitigation, adaptation, and resilience.^{1,7}

As healthcare professionals with a unique focus on medication management, pharmacists have important roles in this response. For example, to support climate change adaptation, pharmacists' expertise will be needed to help patients and communities understand how increasing temperatures may affect medication and chronic disease management.^{8,9} Pharmacists are also well placed to mitigate the adverse environmental impacts of pharmaceuticals, such as GHG_e associated with their manufacture and distribution, direct chemical effects of active pharmaceutical ingredients in waterways and soil, and pharmaceutical waste disposal.^{10,11} Corresponding mitigation strategies include

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optimising medication regimens, making low-emissions purchasing decisions, and facilitating appropriate pharmaceutical waste management.¹¹ Thus, diverse roles in both adaptation and mitigation contribute to environmentally sustainable pharmacy practice (ESPP): pharmacy practice that minimises the adverse environmental effects of pharmaceutical care across the entire medicines-use continuum.

Professional organisations have highlighted pharmacists' ESPP responsibilities. In 2015, the International Pharmaceutical Federation (FIP) released a reference document, 'Green Pharmacy Practice', highlighting opportunities for pharmacists working in all sectors to mitigate the environmental impacts of pharmaceuticals. Thus, ESPP encompasses considerations related to medicines' manufacturing and distribution, prescribing, dispensing, pharmaceutical care, disposal of unused medicines, and the discharge of pharmaceutical or metabolic waste into the environment.¹² ESPP also aligns with the Australian Health Practitioner Regulation Agency's Code of Conduct ('Principle 6: Practitioners have a responsibility to contribute to the effectiveness and efficiency of the healthcare system and use resources wisely'¹³) and the Pharmaceutical Society of Australia's Code of Ethics ('Care principle 3b: A pharmacist facilitates timely access to, and promotes equitable and sustainable use of, healthcare resources in an environmentally responsible manner'¹⁴).

Recently, there have been calls for pharmacy students to receive ESPP education to meet these responsibilities identified by the profession, aligned with broader calls for integration of planetary health education across health professions curricula.¹⁵⁻¹⁷ The Australian Pharmacy Council (APC) Accreditation Standards for Pharmacy Programs 2020 (Updated in 2022) do not explicitly mention environmental sustainability, but they require the pharmacy curriculum to be underpinned by "safe and socially accountable practice", and are supported by guidance on related curriculum content (e.g., learning domain 1: the health care consumer, "requires pharmacists to apply their understanding of the biological, physiological, cultural, environmental, psychological and social foundations of treatment.")^{18,19} Although this guidance does not currently include examples of ESPP content, several of the required Pharmacy Learning Domains could include ESPP-related topics as indicative elements, and some ESPP-related topics could be relevant examples that would fit under multiple domains. However, the implementation of ESPP education is in its early stages globally, and few pharmacy schools have integrated climate and health into mandatory coursework.²⁰⁻²² As the 2021 Association for Medical Education in Europe (AMEE) Consensus Statement highlights, integrating ESPP into pharmacy curricula and course accreditation standards presents an opportunity to embed cross-cutting principles, values, and skills which would support students developing a range of practice-relevant competencies.¹⁷

Alongside this expert consensus, pharmacy educators evaluating whether and how to implement ESPP education may also seek to understand and consider students' perceptions, as part of a needs assessment to inform the curriculum development process.^{23,24} As new members of the profession, pharmacy students' perceptions may include unique insights about ESPP due to their age and prior education. Therefore, their perspectives may also inform pharmacists and professional organisations seeking to understand how they are meeting their responsibilities in this area. This study aimed to explore pharmacy students' knowledge, beliefs, and perceptions towards environmental sustainability, their environmental attitude, and their experience of receiving education during their pharmacy degree on ESPP, planetary health, and climate change concepts.

2. Methods

2.1. Development of the survey instrument and testing

The survey comprised an anonymous, online questionnaire delivered using Qualtrics software (Qualtrics, Provo, UT). It was developed from 2 existing instruments which were combined into one online survey. The

first instrument was a questionnaire used for previously published surveys of dental students' perceptions and curricular experience of environmentally sustainable practice in the United States and United Kingdom (UK).^{25,26} We adapted and rephrased questions where needed to ensure relevance to ESPP and the Australian context. We did not validate the adapted questionnaire for its application in the context of ESPP among pharmacy students in Australia, as the changes made were minor (e.g. changing "dental" to "pharmacy", including a definition of ESPP from FIP) and we did not consider the settings to be sufficiently different to require re-validation (health professionals' preparation for practice in high-income countries with well-developed health systems). The second instrument was the revised 15-item New Ecological Paradigm (NEP) scale, a validated scale measuring environmental worldview. Respondents indicate agreement with scale items using a 5-point Likert scale. To reduce response bias, even-numbered items were phrased such that disagreement indicated a pro-environmental worldview, and reverse-scored accordingly.²⁷ A higher cumulative score (scale 15-75) and/or mean score (scale 1-5) indicated a more pro-environmental worldview.

The survey was pilot tested by pharmacy interns and pharmacists for functionality, comprehensibility, and time taken to complete, and revised accordingly. The final survey used adaptive questioning and consisted of 35 questions, with up to five more questions displayed conditionally based on responses to other items. Questions were presented in order and not randomised or alternated. Generally, there were 5 questions presented per page (ranging from 1 to 8 questions), and a maximum of 14 pages to complete the survey, including the explanatory statement and response recorded pages. The full survey, along with flow and page breaks, can be found in Appendix A.

2.2. Study population

This was an open survey, available to students who were enrolled in an accredited entry-to-practice pharmacy degree program at one of the 18 Australian universities offering such a program.

2.3. Administration of the survey

The survey accepted responses from 25 May 2022 to 31 December 2022. Students were invited to participate through social media platforms, student organisation group events, chats and pages, and direct approach (see Appendix B for recruitment materials). The student organisations' group events, chats and pages were formal and informal places that pharmacy students access for peer support. Investigators also asked pharmacy academics to share the survey invitation with their students. Participation was voluntary and no incentives were offered for participation. Informed consent was implied by continuing to the survey after viewing the explanatory statement (full statement available in Appendix C) on the landing page. All closed-ended questions required responses. Participants could navigate back to previous pages to change or check responses before submitting. Participants were allowed to pause and return to complete the survey within two weeks without losing their answers. Once submitted, responses could not be changed.

2.4. Quantitative and qualitative analyses

Quantitative and qualitative data, from closed- and open-ended survey items respectively, were analysed separately. Interpretations were drawn from consideration of these analyses separately and together.²⁸

Demographic characteristics were reported as numbers, percentages, and means with standard deviation or median with interquartile range where appropriate. Where Likert scales were used, response options were adapted to the statement or question and consisted of standard levels: 'extremely', 'quite', 'moderately', 'slightly', and 'none'. As these were considered to be ordinal variables, correlations between Likert

scale responses and NEP category were evaluated using Kendall's τ_b coefficient. A Chi-square test was used to evaluate independence between NEP category and nominal variables. Internal consistency of NEP scores was tested using Cronbach's alpha. Incomplete survey responses were excluded from the analysis. IP addresses were not used to identify potential duplicate entries.

Qualitative data from responses to the two open-ended questions were thematically analysed by two researchers (CF and JS), using a reflexive, recursive approach.^{29,30} Initially, each researcher inductively coded the data from responses to the question, 'What environmental sustainability activities have you engaged in outside of your educational experience?', independently. CF and JS then reviewed each other's preliminary codes, consolidated similar codes, and agreed that the combined set of codes reflected all identified meanings in this subset of the data. This process was repeated for responses to the question, 'What other comments would you like to make?'. Additionally, if any individual participant answered both free-text questions, their two responses were considered holistically to ensure all meanings could be captured.²⁹ CF and JS generated subthemes and initial themes across the full qualitative dataset independently, then developed and defined final themes through negotiation and discussion.

2.5. Ethical approval

This study was approved by the Monash University Human Research Ethics Committee (project number 31215). Where possible, the results are reported according to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES).³¹

3. Results

3.1. Sample population

A total of 242 responses were collected from 7722 potential respondents³² (3%), with 164 respondents (68% completion rate) who finished the survey (Table 1), from 16 different universities. Most respondents (72.6%) were studying pharmacy as their first degree and had completed at least some of their primary school education in Australia (76.2%).

Women and Victorian students were overrepresented in the sample: women comprised 72.6% of our sample compared with female pharmacists comprising 63.7% of registered pharmacists in Australia, and 48.8% of respondents were studying at a university in Victoria compared to 25.9% of registered pharmacists with a principal place of practice in that state.³² The median mean NEP score was 3.7 (interquartile range 3.4–4.0) (Appendix D) and scores had acceptable internal consistency (Cronbach's alpha 0.721). There were 62 respondents (37.8%) with a cumulative NEP score of 59 or greater, a score which indicates agreement or strong agreement with 'pro-environmental' worldview on every NEP item.³³

3.2. Knowledge of environmental sustainability

Most respondents had received information on environmental sustainability, planetary health and/or climate change before commencing their pharmacy degree (98.8%) (Table 1). Despite this, 28% ($n = 46$) of respondents felt they understood environmental sustainability concepts, including climate change, only slightly well or not at all. Only 10% ($n = 17$) of respondents rated themselves quite or extremely knowledgeable on ESPP (Fig. 1).

3.3. Extra-curricular environmental sustainability activities

Many respondents ($n = 108$, 65%) provided examples of extra-curricular environmental sustainability activities they had undertaken. One respondent mentioned their pharmacy workplace. Overall

Table 1
Demographics of survey participants.

Characteristic	Total n=164
Age in years, median (IQR)	22 (20–23)
Gender, n (%)	
Man	39 (23.8)
Woman	119 (72.6)
Other or prefer not to answer	6 (3.7)
Studying their first degree, n (%)	118 (72.0)
Current year level of pharmacy degree, n (%)	
First	28 (17.1)
Second	29 (17.7)
Third	35 (21.3)
Fourth	72 (43.9)
Location of University, n (%)	
Victoria	80 (48.8)
New South Wales/Australian Capital Territory	28 (17.1)
Queensland	25 (15.2)
Western Australia/Northern Territory	7 (4.3)
South Australia	18 (11.0)
Tasmania	6 (3.7)
Completed primary schooling in Australia, n (%)	125 (76.2)
NEP score	3.7
Individual mean score, median (IQR)	(3.4–4.0)
Individual cumulative score, mean (SD)	55.6 (6.8)
NEP category, n (%)	
Pro-environmental (cumulative score of 59–75)	62 (37.8)
Mid-environmental (cumulative score of 39–58)	102 (62.2)
Anti-environmental (cumulative score of 0–38)	0 (0)
Received information on environmental sustainability, planetary health and/or climate change before commencing their pharmacy degree, n (%)	162 (98.8)
In the following settings, n (%)	
Primary school	108 (65.9)
Secondary school	138 (84.1)
Previous degree or vocational training	26 (15.9)
Family	68 (41.5)
Friends	83 (50.6)
News outlets	113 (68.9)
Internet (e.g. social media)	136 (82.9)

IQR = interquartile range; NEP=New Ecological Paradigm; SD = standard deviation.

qualitative analysis identified five themes, 'inaction', 'sustainability actions in personal life', 'sustainability actions in workplace', 'passive environmentalism' and 'active environmentalism', which are presented in Table 2 alongside representative quotations. Fig. 2 shows the relationships between codes, subthemes and themes identified during the thematic analysis.

3.4. Curricular experience with environmental sustainability

There were 14 respondents (8.5%) from 6 different universities who were aware of any ESPP content in their pharmacy school curriculum. Nine (5.5%) were aware of being assessed on ESPP content. Interest in learning about ESPP was much higher, with 62% ($n = 101$) of respondents indicating they were quite or extremely interested (Fig. 1). When asked where they saw effective teaching opportunities for ESPP, 56.7% ($n = 93$) of respondents selected both classroom and clinical settings, 56.1% ($n = 92$) indicated activity-based classroom learning, such as workshops or tutorials, and 51.8% ($n = 85$) selected online or face-to-face lectures. There was higher demand for ESPP teaching in community ($n = 76$, 46.3%) compared to hospital ($n = 63$, 38.4%) clinical settings.

3.5. Future practice

Most respondents saw ESPP as relevant ($n = 115$, 70%) and important ($n = 114$, 70%) to their future practice as a pharmacist (Fig. 1). Respondents' NEP category were significantly but not strongly

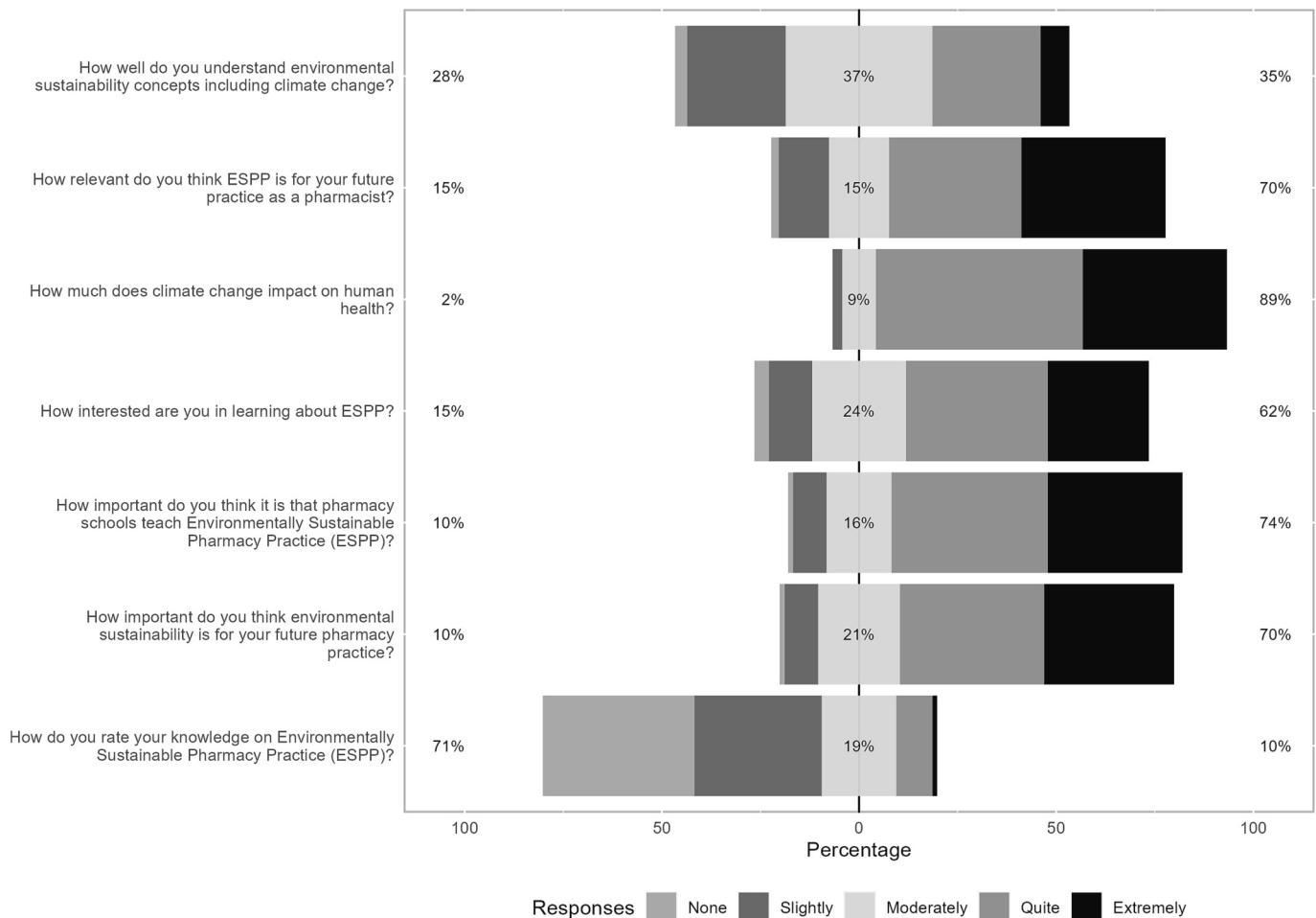


Fig. 1. Knowledge and attitudes statements with Likert scale response items.

correlated with these beliefs (Appendix D); however, these results must be interpreted with caution due to the small sample size. A larger majority of respondents ($n = 154$, 93.9%) believed the pharmacy profession had a responsibility to undertake sustainability initiatives in the delivery of pharmaceutical care. Fewer respondents ($n = 138$, 84.1%) believed the pharmacy profession had a professional responsibility to help the public adapt to the impacts of climate change. Neither of these answers were significantly dependent on NEP category ($p = 0.85$ and $p = 0.06$, respectively).

3.6. Other perceptions about environmental sustainability

When prompted, 24 respondents provided extra comments. Thematic analysis of these data generated 9 themes (see Table 3 for definitions and representative quotations). Students expressed perceptions and beliefs about which aspects of medication use and healthcare were least environmentally sustainable, what challenges needed to be overcome to achieve ESPP, who was responsible for acting, and possible co-benefits of ESPP. Students had observed limited ESPP in their workplace or placement settings. They expressed desires for advocacy by the pharmacy profession, and highlighted the need for larger-scale change, including in the pharmaceutical industry.

Analysis of responses to the free-text questions from respondents who answered both questions did not yield additional themes. However, of these students, those who described ESPP as irrelevant to pharmacists (e.g. Participant 68, 'not our job') also reported no personal engagement in extra-curricular sustainability activities ('none').

Considering individual respondents' NEP categories alongside their

qualitative data revealed that students with pro-environmental attitudes had not necessarily engaged in extra-curricular environmental sustainability activities, and that mid-environmental attitudes did not preclude students from engaging in 'protests and online activism' (Participant 42) or 'being sustainable in daily life ... recycling, picking up litter, etc.' (Participant 27). All students who highlighted the need for systems change had pro-environmental attitudes.

4. Discussion

To our knowledge, this is the first study to describe pharmacy students' knowledge and attitudes towards ESPP and one of the first to explore students' opinions regarding environmental sustainability content in pharmacy curricula. The main finding of this study was that, despite a lack of knowledge and education about ESPP, most pharmacy students in our sample saw ESPP as important for their future practice as a pharmacist. Most respondents recognised that climate change impacts human health and believed ESPP should be taught in both classroom and clinical settings. This corroborates the findings of a recent survey of Finnish pharmacy students, in which 75% (56/75) of participants said environmental issues were insufficiently included in pharmacy education.³⁴

Almost all respondents were already familiar with environmental sustainability, planetary health and/or climate change before commencing their pharmacy degree. Indeed, it has often been students who have led calls for the incorporation of climate change and planetary health into health professions' curricula.³⁵⁻³⁷ However, despite a high level of familiarity with these issues, participants in this survey did not

Table 2

Themes and representative quotations from student responses regarding environmental sustainability activities undertaken outside their educational experience.

Theme	Definition	Representative quotations (participant number, NEP category)
Inaction	No engagement	'N/A' (P17, pro-environmental) 'None' (P129, mid-environmental)
Sustainability actions in personal life	Action to improve environmental sustainability in daily life	'I attempt to minimise my plastic use by using reusable containers, buying products with minimal packaging...' (P72, pro-environmental) 'Being sustainable in daily life - being mindful of materials I use and purchase, recycling, picking up litter, etc.' (P27, mid-environmental) 'Taking public transport' (P6, pro-environmental) 'Reducing power and gas use' (P112, mid-environmental) 'Reducing the amount of meat that I eat' (P122, mid-environmental) 'Planting native plants' (P153, pro-environmental)
Sustainability actions in pharmacy workplace	Action to improve environmental sustainability in pharmacy	'Implemented Terracycle in the pharmacy ...counselled patients on where to dispose medicines and blister packs' (P93, pro-environmental)
Passive environmentalism	Learning or raising awareness about environmental issues; or supporting organisations that protect or advocate for the environment	'Supporting ecological conservation charities' (P133, pro-environmental) 'Supporting political groups that advocate for the environment and animal protection' (P153, pro-environmental) '... engaging in conversations about the environment and sustainability' (P116, pro-environmental) 'University climate change conference' (P97, pro-environmental) 'Independent study' (P103, pro-environmental)
Active environmentalism	Action to promote environmental sustainability at a larger scale, or to directly care for the environment beyond daily life	'Environmental club (planting & composting groups) at high school' (P26, mid-environmental) 'Tree planting days, Clean Up Australia days' (P54, mid-environmental) 'Protests and online activism' (P28, mid-environmental) 'Climate change protests' (P42, pro-environmental)

express confidence in their knowledge of sustainability concepts, either in general or specifically related to ESPP. This may reflect students making a relative assessment of their knowledge of these concepts compared to recently studied topics, and likely reflects a lack of ESPP in curricula. For example, in a national study of Canadian medical students, 84.9% (1210/1424) of participants indicated they knew less about the health impacts of climate change than other topics in their curricula.³⁸ Similarly, in a US study, 75% (284/378) of dental students surveyed considered themselves “not knowledgeable at all” or “only slightly knowledgeable” about environmentally sustainable dentistry.²⁶ This stated lack of knowledge demonstrates the need for additional ESPP education.

Survey respondents identified ESPP education as a way to influence

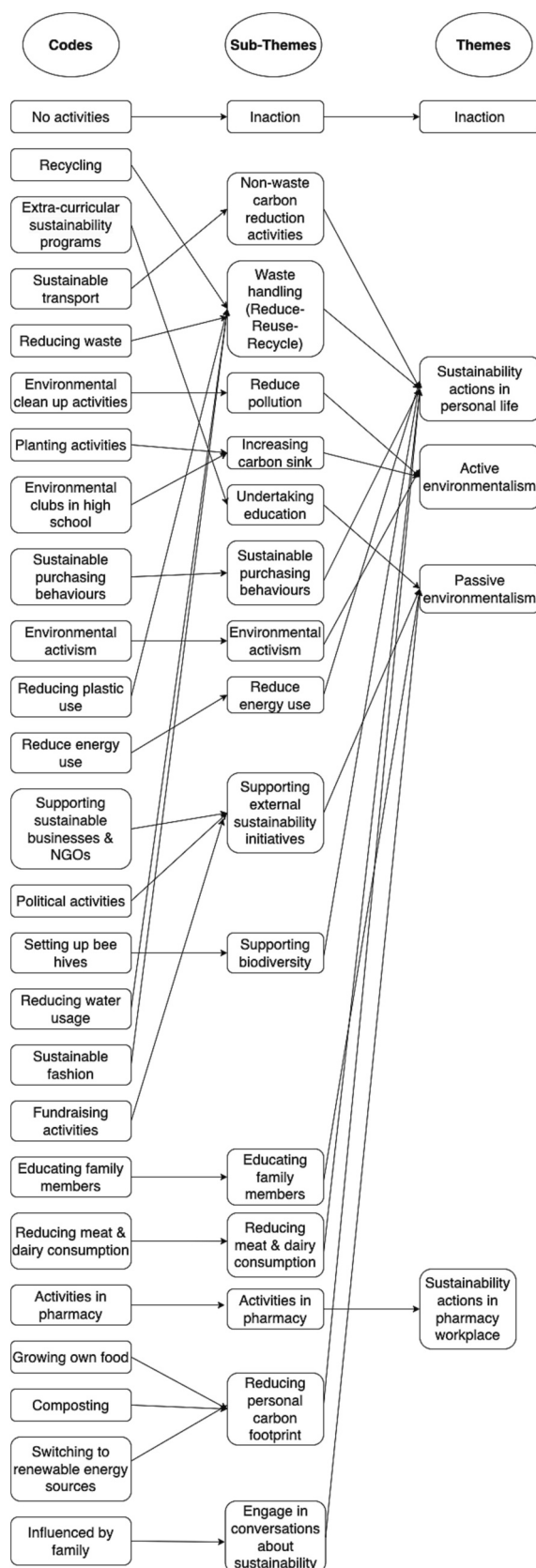


Fig. 2. Coding tree for participants' responses regarding environmental sustainability activities undertaken outside their educational experience.

Table 3

Themes and representative quotations from student responses to a prompt for additional comments.

Theme	Definition	Representative quotations (participant number, NEP category)
Pharmacists have a responsibility	Belief that pharmacists have a professional responsibility and/or ethical obligation to mitigate environmental harms	'Our profession seeks to aid all individuals and this should be seen in how we treat our environment we practice in to ensure it is sustainable for our future' (P112, mid-environmental) 'No profession or person should be exempt from doing our part for our planet' (P87, pro-environmental) 'I feel like health practitioners not actively contributing to people dying is somewhere close to the bare minimum of basic Not Having Conflicts Of Interest and just Not Being An Awful Health Practitioner In General' (P145, mid-environmental)
Not pharmacists' role or responsibility	Belief that environmental sustainability is irrelevant or outside the scope of pharmacists' roles and responsibilities	'A pharmacist job is to provide and educate people on medicines Nothing to do with climate change Not our job' (P68, mid-environmental) 'I don't believe pharmacists have a responsibility to assist the public in adapting to climate change impacts but we need to have plans in place if these things do occur' (P161, pro-environmental) 'Nuclear power is there, use it' (P102, mid-environmental)
Responsibility of the pharmaceutical industry	Perception that the pharmaceutical industry has a greater responsibility and needs to reduce its environmental footprint	'The pharmaceutical industry has an important role to play in their packaging and delivery of medications' (P116, pro-environmental) 'Big companies have the biggest impact and should be held accountable by government and legislation instead of passing responsibility on to the consumer' (P126, mid-environmental) 'Pharmaceutical companies ... have a much larger responsibility and burden on producing harmful pollutants compared to the local community pharmacy or hospital' (P21, mid-environmental)
Environmental issues in healthcare	Perception that aspects of healthcare provision are not environmentally sustainable	'There is a large amount of waste created, with limited recycling' (P27, mid-environmental) 'It is challenging in terms of single use medical devices but we should do all we can in all other areas to combat this' (P72, pro-environmental)
Desire for environmentally sustainable profession	Desire for advocacy and change towards ESPP by the pharmacy profession	'I would really like to see pharmacy advocate and change to be sustainable and environmentally friendly' (P153, pro-environmental) 'I'd love to see more ESPP taught, ... it feels like an area that's not well understood or practised' (P95, pro-environmental) 'Teaching about this should influence change in the next wave of pharmacists ... it would be difficult for one pharmacist but if others had been exposed to ESPP they may be more on board and can help create change' (P144, pro-environmental)
Caring for the environment can engender public trust	Belief that pharmacists can earn trust by acting to protect the environment	'Pharmacist[s] should be trusted by the public and caring for the environment is one way they can do that' (P142, mid-environmental)
Pharmacists' roles in environmental sustainability	Perception of specific ways pharmacists can promote environmental sustainability in practice	'I don't think many people understand the implications of throwing out medications in the normal waste bin instead of bringing them into a pharmacy to be properly disposed of' (P63, mid-environmental)
Environmental sustainability action needs top-down and bottom-up support	Perception of barriers to individual action, and belief that top-down and/or bottom-up support is needed to drive systems change towards environmental sustainability	'It is difficult as a single pharmacist to create change in larger systems...' (P144, pro-environmental) 'If we can make it easy for people to make environmentally sustainable decisions I think people will be more likely to engage' (P116, pro-environmental) 'Much of the blame is placed on the consumer to individually fix this issue rather than collectively breaking down larger manufacturers, but it has been improving with the pledge for 0% carbon' (P110, pro-environmental)
Tension between environmental sustainability and other priorities	Perception that environmental sustainability must be balanced against other priorities in pharmacy practice	'Most medications come in cardboard boxes with plastic in the blister packets because it's kinda needed. Especially for something as important as the actual health and well-being of out (sic) customers' (P128, mid-environmental) 'It is important that confidentiality is still kept' (P74, mid-environmental) 'Not enough pharmacies are offering ways of recycling blister packs which means it is expensive for the pharmacists who do recycle them' (P157, pro-environmental)

change and promote ESPP in practice, alongside the top-down support necessary to overcome other barriers. Similarly, Shaw and colleagues propose sustainable healthcare education as a critical part of a systems approach to promoting planetary health.¹⁷ Respondents also suggested that education about ESPP needed to include examples from practice to be effective. Conversely, in some medical schools, students working with staff have co-designed and implemented 'climate change and health' curriculum content.^{35–37} Co-creating sustainable healthcare content has the potential to develop students' global citizenship, enhance faculty development, and support curricular integration of the diverse perspectives necessary for planetary health, including Indigenous perspectives.^{17,39} Despite the high level of interest, and demonstrated co-

design models, initial calls for ESPP integration into curricula have not included leveraging student voices.^{16,20}

Despite the benefits of engaging students in curriculum development, students' perceptions and self-identified learning needs should not be the sole drivers of this process. One limitation is that students may call for more education about a topic without understanding its relative importance compared to other topics in the curriculum; however, in the case of ESPP education, students' expressed preferences align with expert consensus and the identified needs of the profession and society.^{1–3,7,12–15} Another limitation, suggested by the qualitative results of this study, is that students' perceptions of environmental sustainability may be relatively narrow in scope compared to the planetary health

knowledge, values and skills that the AMEE Consensus Statement proposes all health professionals need.¹⁷ This finding may in part reflect the fact that students were responding to the narrow definition of ESPP provided in the questionnaire. However, it is also likely to represent learning needs related to systems thinking, determinants of health and inequities, and other planetary health concepts, and underscores the importance of curricular integration to ensure critical connections are made.

Australian pharmacy course accreditation standards emphasise socially accountable practice including cultural safety, 'reduction of disparities in health care' and 'addressing community aspirations for health'.¹⁸ Therefore, it is interesting that some students did not believe that pharmacists should help the public adapt to the impacts of climate change, despite agreeing that pharmacists should improve the environmental sustainability of pharmacy practice and understanding the impact of climate change on health. This gap may indicate that some pharmacy students have not made a connection between improving public health and improving healthcare sustainability, and the implications of those actions on the health status of the community. Additionally, these respondents may not have recognised that adapting to the impacts of climate change includes adapting to its health impacts. Meanwhile, known pharmacist roles in adaptation include helping to secure medication supply in natural disasters exacerbated by climate change, and public health responses to extreme heat.^{40,41} Alternatively, respondents may not consider individual practice as part of public health at this scale, or believe that responsibility lies elsewhere (for example, with the government or pharmaceutical industry, as suggested by the qualitative findings).

As governments and health systems set environmental impact targets, there is an increasing need for health professionals with knowledge and skills in both clinical and planetary health domains.¹⁷ 'Sustainability lead' positions in health organisations, sustainability-focused education and workforce development roles, and policy roles in professional organisations offer broadened career pathways for pharmacists with such expertise. Conversely, if pharmacists are not prepared to join working groups or committees that help guide organisational transitions towards sustainability, critical aspects of medication management may be overlooked. Other health professions are charting environmentally sustainable paths forward regardless of pharmacy involvement.⁴²⁻⁴⁴ Increasingly, working in interprofessional healthcare teams will require knowledge of environmentally sustainable healthcare.

Incorporating further content into an already crowded pharmacy curriculum can be challenging. However, it is possible to integrate ESPP into existing curricula with minimal disruption due to its alignment with other core content, as highlighted earlier.^{18,21,35} Further facilitating this, open-access teaching resources are increasingly available. For example, the Global Consortium on Climate and Health Education maintains an open repository of teaching cases mapped to standard clinical and public health-related topics.⁴⁵ In Australia, the medical curriculum has already been mapped to integrate climate change and health into established organ-systems based teaching, with 'ready to use' resources developed to fit in to existing programs.^{46,47} Additionally, another strategy for overcoming curricular crowding is to shift emphasis from obtaining knowledge to developing competencies. Accordingly, the AMEE Consensus Statement emphasises transferable skills and values, and also provides guidance for health educators on planetary health content and learning and assessment resources.¹⁷

Limitations of this study were the sample size, and representativeness. While the number of potential participants who actually received the survey invitation was unknown, response rates of 5–10% have been suggested for reliable sampling in a large cohort of students, which was not achieved in this study.⁴⁸ However, even at 5–10%, it is likely participants who chose to complete the survey had pre-existing interest in environmental sustainability, while those who had no interest were not motivated to respond. This nonresponse bias is supported by our sample having a higher percentage of pro-environmental participants (37.8%)

compared with a study of Australian and UK hospital pharmacists' engagement with pro-environmental behaviours (22.7% and 20% respectively).³³ However, our findings did not suggest a strong correlation between NEP category and ESPP beliefs. It is difficult to estimate the magnitude of the nonresponse bias, as the extent to which the student population is representative of the overall pharmacy profession, and then the extent to which our sample was representative of the student population, is unknown. A conservative interpretation of these findings would suggest a lower level of interest overall, but still suggests that even the most environmentally engaged students did not receive much ESPP education.

5. Conclusion

The results of this study suggest that pharmacy students in Australia lack knowledge of ESPP and that this reflects limited inclusion of ESPP content in pharmacy curricula. However, most pharmacy students were familiar with environmental sustainability concepts, and saw ESPP as important for their future practice as a pharmacist. There was demand for ESPP to be taught in both classroom and clinical settings, and for the profession to advocate for larger-scale change towards environmentally sustainable medicines use. This is an important area for development in pharmacy curricula and practice, to promote public health and keep pace with broader transitions towards sustainable healthcare. A curriculum redesign of this nature may seem daunting to pharmacy educators; however, many learning and teaching resources are available already. Ongoing research is needed to map ESPP content and evaluate effective delivery and assessment modes.

CRedit authorship contribution statement

Esa Y.H. Chen: Conceptualization, Formal analysis, Writing – original draft. **Catherine Forrester:** Conceptualization, Formal analysis, Writing – review & editing. **Aisling M. McEvoy:** Writing – review & editing. **Judith Singleton:** Conceptualization, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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Supplementary data

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