



This is a repository copy of *Environmental sustainability: the attitudes and experiences of UK students in the oral health profession*.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/207679/>

Version: Submitted Version

---

**Preprint:**

Durnall, O., Mulligan, S. [orcid.org/0000-0001-7979-3696](https://orcid.org/0000-0001-7979-3696), Dixon, J. [orcid.org/0000-0002-3499-175X](https://orcid.org/0000-0002-3499-175X) et al. (1 more author) (Submitted: 2023) Environmental sustainability: the attitudes and experiences of UK students in the oral health profession. [Preprint - Research Square Platform LLC] (Submitted)

<https://doi.org/10.21203/rs.3.rs-3295473/v1>

---

© 2023 The Author(s). This preprint is made available under a Creative Commons Attribution 4.0 International License. (<https://creativecommons.org/licenses/by/4.0/>)

**Reuse**

This article is distributed under the terms of the Creative Commons Attribution (CC BY) licence. This licence allows you to distribute, remix, tweak, and build upon the work, even commercially, as long as you credit the authors for the original work. More information and the full terms of the licence here:

<https://creativecommons.org/licenses/>

**Takedown**

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing [eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk) including the URL of the record and the reason for the withdrawal request.



[eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk)  
<https://eprints.whiterose.ac.uk/>

# Environmental Sustainability: The Attitudes and Experiences of UK Students in the Oral Health Profession

Olivia Durnall (✉ [oliviadurnall@gmail.com](mailto:oliviadurnall@gmail.com))

University of Sheffield

Olivia Durnall

University of Sheffield

Steven Mulligan

The University of Sheffield <https://orcid.org/0000-0001-7979-3696>

Jonathan Dixon

[jonathan.dixon@sheffield.ac.uk](mailto:jonathan.dixon@sheffield.ac.uk) <https://orcid.org/0000-0002-3499-175X>

Nicolas Martin

The University of Sheffield <https://orcid.org/0000-0002-6380-559X>

---

## Research

**Keywords:** environmental sustainability, dental education, curriculum, survey, oral health professional

**Posted Date:** September 21st, 2023

**DOI:** <https://doi.org/10.21203/rs.3.rs-3295473/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

**Additional Declarations:** There is no duality of interest

---

# Environmental Sustainability: The Attitudes and Experiences of UK Students in the Oral Health Profession

Olivia Durnall, Steven Mulligan, Jonathan Dixon and Nicolas Martin

## Abstract

**Objective:** This study aims to provide further clarity and detail into the students' attitudes and review towards Environmental Sustainability in Dentistry (ESD) in the provision of oral healthcare. Also, the manner and extent in which ESD is included in the current undergraduate Oral Healthcare Professional curricula. This study focuses on the perspective of undergraduate dental students [Bachelor of Dental Surgery (BDS)] and dental hygiene and therapy students [Dental Hygiene and Dental Therapy (DH&DT)] from UK dental schools, as a national representative case study.

**Methods:** A multi-centre study, cross sectional online survey of undergraduate BDS and DH&DT students in UK based dental schools. Data analysis was conducted through descriptive statistics and thematic analysis.

**Results:** 263 students from thirteen UK schools completed the survey, resulting in a national school response rate of 68.4%, showing a strong representation of this student population across the UK. Key findings are: 97.3% of students believe that the dental profession should be more actively engaged in environmental sustainability, however students currently having very little exposure to ESD at an undergraduate level. 76.8% of students expressed that they are concerned about the impact that oral healthcare provision has on the environment, but only 23% of students have independently researched ESD. 46.4% believe that 'The provision of oral healthcare is my priority as a clinician and this has unavoidable environmental consequences that we need accept'. Students were clearly concerned about the impact of the addition of ESD into the curricula would have on their studies and progression. There is very little student-reported inclusion of ESD in the school curricula. Notwithstanding, students identified the importance of ESD in the profession and the need for this to be included in their curricula, but were very apprehensive of the effect that this may have on their already congested course.

**Conclusions:** Students identify that our oral healthcare professions should become more engaged in efforts to mitigate the negative impacts from our activities on the environment. The main way this can be achieved is through education at all levels. The strong insight into student's level of awareness and concerns for the impact of oral healthcare provision on the environment is a powerful driver for the inclusion of ESD into the undergraduate curriculum in UK based dental schools. There is clearly identified need for schools to include ESD in the curriculum in a seamless and fully integrated manner so that it does not create a further burden to learning and teaching.

**Key words;** environmental sustainability, dental education, curriculum, survey, oral health professional

**Abbreviations;** Dental Hygienist and Dental Therapy (DH&DT), Environmental Sustainability in Dentistry (ESD), General Dental Council (GDC), Association for Dental Education in Europe (ADEE)

## Introduction

### Sustainability in oral health care

We are currently living in the geological age of the Anthropocene, defined as the period in which human activity has had the most significant impact on the environment<sup>1</sup>. The industrial revolution that began in the UK during the 18<sup>th</sup> century, can be considered as the start of human's significant and irreversible growth. This rapid evolution resulted in a shift towards mass production that required vast amounts of energy from unchecked non-renewable sources. This in turn, has caused the current global climate change crisis. The increased pollution, burning of fossil fuels and human population growth have all resulted in the destruction of habitats worldwide<sup>2</sup>. With global average temperatures now significantly higher than pre-industrial levels<sup>3</sup>, it is clearer than ever the impact that climate change is having on the world.

The recently published COP26 special report on climate change and health, highlights the impact of healthcare on the environment<sup>4</sup>, with evidence of how 'health professionals worldwide are already responding to the health harms caused by this unfolding crisis'<sup>5</sup>. Healthcare systems are responsible for around 5% of global greenhouse gas emissions, of which oral health is an important contributor<sup>6,7</sup>. The delivery of general healthcare is currently not environmentally, socially or financially sustainable due to high amounts of CO<sub>2</sub>e and waste generated<sup>6-9</sup>. It is paradoxical that healthcare, with the central tenet to support and protect health and life, contributes to climate change through unsustainable practices and in doing so to disease.

The whole oral healthcare community, including clinical professionals and industry, recognise that we have a responsibility to deliver products and interventions that improve oral health in an environmentally sustainable manner<sup>10</sup>.

In recent times, the combined efforts of the oral healthcare profession and the oral health industry have improved treatment strategies and modalities, including the innovation and development of excellent technologies, materials and products to provide this care. These combined efforts have, to date been largely focused on the end goal, to prevent and manage oral diseases. Today, we have a further understanding, that these laudable intentions and efforts, are having the unintentional consequence of contributing to the global net rise in CO<sub>2</sub>e (carbon dioxide equivalent) emissions and pollution<sup>10</sup>.

The oral healthcare profession, in the same manner as any other service or industry, has a responsibility and vital role in climate change mitigation efforts through comprehensive engagement in sustainable practices. Sustainable oral healthcare could result in substantial CO<sub>2</sub>e reductions, reduced plastic usage and waste generation. In addition and as a direct result of this, it could lead to enhanced patient care, staff satisfaction, cost savings and improved quality of life<sup>11-13</sup>.

### Sustainability awareness through Education

Education is considered as the fundamental component of any remediation strategy, with a focus on increasing awareness and identifying remediation solutions for each sector and for the supply chain as a whole<sup>14,15</sup>. Effective education programmes should include communication, dissemination and participation at all levels<sup>16,17</sup>.

There is an increasing understanding of the structure and content of 'sustainability' knowledge required at an undergraduate level<sup>10,14,15,18-21</sup>. Essentially, the focus of environmental sustainability in oral healthcare, is on the delivery of a good oral healthcare strategy that considers the four domains: Effective preventive care regimes, good operative care, integrated patient care and professional ownership of care. These domains apply to all aspects of the management of systemic diseases and by targeting them jointly it benefits the patient, society with low environmental impacts (low use of resources, low carbon footprint and low waste)<sup>22,35</sup>. Educational messages should focus on disease-prevention regimes and maintenance regimes with sustainable oral hygiene practices at home. The Association for Dental Education in Europe (ADEE) has been a key driver to embed Environmental Sustainability in Oral Health Professional (OHP) curricula at a European level. Two consensus documents have been published from special-interest group meetings at the annual ADEE conference. The first was an initial scoping document to identify a need to embed ES and consider key messages to begin teaching this concept<sup>18</sup>. The second is a publication of consensus-agreed specific learning outcomes and recommendations for teaching, learning and assessment for ES<sup>23</sup>. In addition, the O-Health-Edu vision for OHP education in Europe, that was published after sector wide consultation, incorporates ES as a key element<sup>23</sup>. With educational bodies such as ADEE increasingly publicising its positive views towards the inclusion of ESD into the curriculum, there is hope that universities and other governing bodies will follow suit in recognising the impact that dentistry has on the environment and how education is a key strategy to a more sustainable future<sup>24</sup>.

At the professional end-user point (within dental clinics), there is a need for education of the entire dental team, including reception staff, nurses, clinicians and also patients as active co-participants of their care. In the formative years of the oral healthcare undergraduate curriculum, there is an invaluable opportunity to increase awareness and remediation actions through carefully channelled educational programmes<sup>10</sup>.

For any educational approach to be successful it is essential to obtain and consider the attitudes of students as the recipients and co-managers of their education. Two recently published studies consider this in a UK and USA setting<sup>25,26</sup>. Both studies had similar aims with regards to assessing the current level of Environmental Sustainability in Dentistry (ESD) being taught to pre-doctorate / undergraduate students and assessing the student's level of interest and desire for a change in their curriculum.

Joury et al. (2021) gathered opinion from both students and educators across two dental schools, one in the UK and one in the USA<sup>25</sup>. The study demonstrated a positive attitude towards the inclusion of ESD into the curriculum, more specifically from students rather than educators. It highlighted the importance of having a 'bottom-up' approach, which is where end-users help guide policy, that is complemented by a 'top-down' approach (paternalistic guidance from key governing organisations), from either the General Dental Council (GDC) or US equivalent to create a legitimacy to the cause. The study by Gershberg et al. (2021) focused on dental students in US based dental schools only<sup>26</sup>. They found that despite other health professional courses already embedding ES in their respective curricula, dental schools have not yet followed suit. Gershberg et al. found that students have expressed their concern about the impact that the provision of oral healthcare has on the environment and found a baseline eagerness for ESD to be included in the curriculum.

Both these studies have provided the foundation to push the ESD agenda into the curriculum in US-based dental schools, by showing that there is a drive from students to have more ESD based content throughout the course. Nevertheless, further research into the levels of ESD within the dental curriculum is needed to better understand the particular requirements of the students. Students are a key stakeholder of OHP education and as such the student voice is essential in any intervention to improve education or to integrate new concepts.

This study aims to provide further clarity and focused detail into the students' attitudes and behaviours towards ESD in the provision of oral healthcare. Also, the manner and extent to which ESD is included (currently and in the future) into the undergraduate oral healthcare professional curricula. This study focuses on the perspective of undergraduate dental students [Bachelor of Dental Surgery (BDS)] and dental hygiene and therapy students [Dental Hygiene and Dental Therapy (DH&DT)] from UK dental schools, as a national representative case study.

## Materials and Methods

A multi-centre study, cross sectional online survey of undergraduate BDS and DH&DT students was carried out using an online questionnaire that was distributed to all UK based dental schools. Ethical approval was obtained from the University of Sheffield's Research Ethics Committee. Consent was gained through a 'participation statement' that prospective participants had to read and approve before continuing onto the survey questions. Support for this study was obtained from the UK Dental Schools Council<sup>27</sup>. Participation requests were sent to the Heads of School of nineteen UK dental schools for onward internal distribution amongst all the undergraduate BDS and DH+DT student cohorts of each respective school. The survey questions sought to gain an understanding of the attitudes and opinions of UK undergraduate students for the inclusion of sustainability in the curriculum. The questions were devised to ensure that they lacked of bias, were non-leading and easy to understand. The validity of the questionnaire was tested through two focus groups of students at the authors' institution. The survey consisted of thirteen questions that included closed and open questions, Likert scale as well as multiple choice questions. Likert scales allowed for a wider range of answers to be collected, to improve the clarity of the questions and allow for quantification of the data. Multiple choice questions were used to focus responses into key categories, to gain greater understanding regarding the current level of exposure to ESD and ability to increase future awareness of the impact of the provision of oral healthcare. A free text section was included to identify the barriers that they, personally, face to which hinder them from increasing their understanding of ESD and their ability to apply this knowledge in a clinical environment.

All close-ended questions were analysed through descriptive statistics and the data was presented as graphs or charts. Both these tasks were performed using Google Forms auto-generated software. Thematic analysis was used for the single open-ended question as per Braun and Clarke's (2006) six phase approach and resulted in the development and refinement of themes<sup>28</sup>.

## Results

Students from thirteen schools completed the survey, resulting in a school response rate of 68.4%, showing a strong representation of this student population across the UK. Six schools did not respond or wish to participate, identifying student survey fatigue and academic burden as a concern.

The student response rate (as a function of the total number of registered undergraduate students) was 24.5%, with a total of 263 students taking part in the survey from across thirteen UK based dental schools.

From the written responses it is clear that the students had varying degrees of clinical experience dependent on individual levels of progression in their respective courses, with the following key findings:

- There was no difference in opinions of students at different stages of progression within their own dental school curriculum, all showing equal interest in their profession's environmental impact.
- The level of concern for their own personal environmental impact identified that 77.9% of respondents were concerned, of which 17.5% were very concerned (Figure 1).
- Despite this apparent level of baseline concern, only 27% of respondents 'always try' to reduce their personal impact on a day-to-day basis, compared to 54% sometimes trying.

16% of respondents stated that 'I would like to do more but don't know how' (Figure 2).

**[Insert Figure 1 here]**

- 90% of students have considered the impact that the provision of oral healthcare has on the environment, with 85.6% believing that it is our responsibility as oral healthcare workers, to provide care in an environmentally sustainable manner.
- 46.4% believe that 'The provision of oral healthcare is my priority as a clinician and this has unavoidable environmental consequences that we need accept' (Table 2). One student responded that *'Environmentally friendly solutions always seem to contradict infection control and therefore cannot be done for patient safety'*, cross infection control and being in a hospital setting were identified by students as barriers to them engaging with impactful solutions at an undergraduate level.

**[Insert Figure 2 here]**

Students own level of concern for the effect that the provision of oral healthcare has on the environment: 76.8% expressed that they are concerned. This was conveyed in the free answer question with many students identifying cross infection control policies procedures, specifically the use of single use plastics and personal protective equipment (PPE), as a barrier to them engaging with impactful solutions to make the provision of oral healthcare more sustainable. A common view amongst many dental students on this topic was clearly expressed by one particular statement *"As dental professionals we use a lot of plastic single use items due to cross infection, but this is very concerning to me and wish there was another way to be more sustainable"*.

A further common finding was their perceived lack of power within the hierarchy of a hospital setting and that their 'student voice' lacked any form of influence. This sentiment is captured by the comment *"As a student we just follow the protocols and guidelines set out by staff or the hospital or the trust the hospital is a part of. It doesn't feel like we can do anything to change any of it"*. A suggestion captured in the responses is to create a mechanism that allows students to have a greater voice with regards to ESD within dental schools. For example, the introduction of sustainability action groups that allows like-minded students and staff to convene and discuss local strategies and action plans to that will make a difference. Sheffield Dental School introduced the Sheffield Oral Sustainability (SOS) group in 2022, this group has allowed students to part-take in local campaigns to promote ESD. Students have expressed that after *"joining a sustainability group I feel more positive about this and feel like my voice is more heard"*.

23.2% of undergraduate students were neither concerned or unconcerned about the effect of oral healthcare on the environment. Another barrier identified by students was a lack of care and/or a lack of time. Many students have the view that *"it's hard enough to do the whole course without having the extra worries, I think it should become more of a concern once you are a practicing clinician rather than as a student"*.



Currently there is very limited exposure to undergraduate students about the effect that oral healthcare provision has on the environment, with 51% saying it's only been mentioned briefly through staff members or informal conversations with peers (53.2%) (Table 3). Only 9% of students believe that they have been taught ESD through more formal means such as lectures. However, despite this lack of current emphasis in the curriculum 97.3% of students believe that the dental profession should be more actively engaged in ESD (Figure 3).

**[Insert Figure 3 here]**

### Current Level of Student Engagement in ESD

Despite students wanting the undergraduate curriculum to have a greater emphasis on ESD it is important to recognise that students are unlikely to take a proactive approach to learning about oral healthcare provision's impact on the environment, as only 23% of respondents independently researched ESD outside of the undergraduate curriculum as either part of a group or independently (Table 3). 76.4% have admitted to not doing any additional research regarding the topic, implying that students will only engage in ESD if it is included as part of the curriculum rather than an additional task that students have to undertake, as students see a lack of time as a barrier to them currently doing independent research on the topic, as seen from this student comment '*The effect we have on the environment is not taught to us and not much time is available to research this*'. Another barrier identified was a lack of knowledge and finding the topic to be overwhelming especially in the current climate, this is another reason for ESD to be included in the curriculum.

It is important for us to acknowledge that eco-anxiety is recognised as a true emotional response to the predicted impact of climate change and is defined as 'a chronic fear of environmental doom'<sup>29-31</sup>. One student authenticated this fear leading to an avoidance of the topic by saying; '*The environmental impacts of dentistry etc, can feel very overwhelming. This is not a feeling which results in productive action*'.

**[Insert Figure 4 here]**

### Methods for Improving Engagement with Students

Students identified social media (66.4%), professional talks (74.9%) and tutor-led discussions (58.9%) as the best way to increase awareness of the impact that oral health provision has on the environment (Figure 4).

The fact that students want information to be relayed to them through professional talks and tutor-led discussions suggests that students want education on the subject to be provided from credible sources in a manner that does not require a significant increase to their existing workload. This is reinforced by one student comment; '*I think a compulsory attendance tutorial with no extra work could be a good way of delivery the teaching*'. However, despite students showing interest in attending professional seminars relating to ESD there are several barriers in place that students are unable to overcome. A significant barrier is that many courses, webinars or seminars are aimed at qualified clinicians and thus require a (UK) General Dental Council (GDC) number to register, this immediately isolates the majority of the student community.

97.7% of respondents have said that being taught ESD at an undergraduate level would have a positive effect on the future impact that dentistry as a profession has on the environment. No participants said that it would have a negative impact and only 2.3% believe that there will be no impact by as a result of the change (Table 3). These results show an overwhelming support for increase awareness and education surrounding the environmental impact that dentistry has on the environment, therefore, suggesting that students would have a very positive response to the inclusion of ESD into the curriculum.

The GDC recently distributed their Safe Practitioners Domains for consideration and commentary which included two learning outcomes relating to environmental sustainability, inspired by the Association for Dental Education in Europe's (ADEE) 2022 Conference that specifically discussed 'Sustainability in Dental Education'<sup>24</sup>. The learning

outcomes include; describing the main principles of sustainable oral healthcare, any challenges or barriers to implementing ESD and understanding the environmental impact of common treatments. If agreed upon and included, this is a positive first step into the implementation of ESD learning objectives into the UK undergraduate dental curriculum. This also highlights that sustainability is a topic that is going to be a common theme in the provision of oral healthcare in coming years and something that will impact all practitioners.

### Barriers to Engagement - Identified by the Student Community

A final free-text question enabled the students to identify and further elaborate on the barriers that prevent the student community from engaging in impactful solutions for the management of oral health care provision and the environment. Seven key themes were identified that are listed in the order of incidence of responses;

1. Hierarchy of a hospital setting (27% of responses)
2. Lack of knowledge (23.2%)
3. Cross infection control policy, especially with regard to COVID-19 pandemic (16.4%)
4. Lack of time (8.2%)
5. Eco-anxiety (6.1%)
6. Lack of care (3.7%)
7. Limited knowledge base within academic tutors (3.7%)

It should be noted that 2% of respondents did not believe there were any barriers in place and 9.2% did not respond to the question.

The barriers identified confirmed the findings raised throughout the survey. Students identified that their main barrier to becoming more sustainable whilst at dental school was the hierarchy present within hospital settings and the SOPs and policies put in place by management. This was summarised by one student; *“As students, we do not have as much impact/authority to help create a change... Following correct procedure for PPE is a main thing that prevents us from reducing waste”*.

## Discussion

This study sought to determine the attitudes and opinions from undergraduate dental and hygiene and therapy students for the inclusion of ESD into their curricula. The strong student response rate with a 68% representation from a total of thirteen UK dental schools indicates that this topic is of significant interest and concern to the undergraduate population.

The results imply that as a cohort, current undergraduates do have a strong baseline level of concern (65%) with regards to the environment, this correlates with the United Nations (UN) findings that half a million of youths worldwide have participated in group projects in their homes, schools and communities relating to climate change<sup>32</sup>. This is confirmed further by a study conducted by the UK Government that showed 80% of 8-15yr olds acknowledge that caring for the environment is important to them and 81% want to do more to protect the environment<sup>33</sup>.

The overwhelming finding that 90% of students have considered the impact on the environment that arises from the provision of oral healthcare is assuring and shows a wide level of awareness across the cohort. However, this finding is worryingly diluted by the fact that nearly half of the respondents (46.4%) identify that the environmental impact from oral healthcare provision ‘is an unavoidable consequence that we need to accept’. There is clearly a big chiasm between perceptions, attitudes and behaviours in the professional setting, that is evident in the formative stage of oral healthcare professionals.

There is no doubt that students are concerned (77.9 % concerned and 17.5% very concerned) about the manner in which their personal activities impact on the environment. Again, this strong attitude is worryingly dampened by a lack of translation of environmental attitudes to actual behaviour change; identified by a 54% of respondents that identify as ‘sometimes try to reduce their personal impact on the environment on a daily basis’. The majority of students appear to have an understanding of how to be more environmentally friendly but do not always see this as significant when it comes to their everyday life. It is therefore important when introducing ESD into the curriculum to impress on students the importance of being environmentally sustainable as often as possible, both everyday life and in their professional work settings. It has been identified that clinician’s often find it difficult to transfer their



home-based behaviours into a clinical setting due to a shift in mindset from environmental citizenship to professional clinical duties. In order to overcome this issue, it is important for members of the dental team to be open to conversations and education on the topic. Once ESD has become a common topic, steps can be taken to implement real actions into the workplace<sup>22</sup>.

Nearly a quarter of the cohort (23.2%) showed ambivalence towards the effect of oral healthcare on the environment; identifying that this was a distraction from their studies, creating an additional time and content burden. The majority of students (76.4%) did not engage in any further formative self-directed learning in ESD outside their curriculum. Students identified a number of reasons for this, highlighting a lack of time, lack of resources, not knowing where to find the correct resources and eco-anxiety. Providing students with the guidance and baseline knowledge of environmental sustainability, with an emphasis on oral healthcare provision, would empower students to do further research on the topic without feeling lost or overwhelmed. Interestingly and despite their reticence or difficulties to engage as undergraduate students, there was overwhelming support (97.3%) for greater engagement of the (qualified/practising) dental profession in ESD. A further finding on this topic highlights that the inclusion of sustainability in oral healthcare curricula is extremely low. Despite the overall guarded responses to the inclusion of sustainability in the curricula, students overwhelmingly (97.7%) accepted that such a move would have a positive effect on the future impact that dentistry as a profession has on the environment.

The results highlight the importance for the inclusion of environmental sustainability in the creation of clinical guidelines and protocols in dental hospitals. This would lead to a seamless adoption of these principles as part of the provision of high-quality care. In turn, this approach would enable students to be able to experience first-hand how to be more sustainable during the provision of oral healthcare whilst in education and subsequently, as practicing professionals.

In terms of delivery modalities, a blend of different formats was considered and advocated, with representation from social media, tutor-led discussions and professional guest presentations/webinars. Social media is a powerful tool that can be utilised to disseminate awareness and information relating to ESD, in a manageable and effective manner. It has the potential to make sustainability a more achievable and understandable goal for dental professionals. The FDI World Dental Federation does this through the use of social media #SustainabilityinDentistry, alongside promoting engagement in their Sustainability Challenges which helps to promote more sustainable practice within dental practices<sup>34</sup>.

Overall, the results from this cross-sectional multi-centre survey provide a strong insight into current perspectives from undergraduate dental and hygiene and therapy students with regards to the topic of ESD in their curricula. Students are concerned about the impact of their (current and future) professional activities on the environment. It is very clear from the results that in order to gain maximum engagement from students, ESD should be integrated into the curriculum. Students would then be less likely to view this as an additional task and this would increase enthusiasm and engagement. The inclusion of ESD within the undergraduate curriculum is viewed in a positive light by all students. Through education on the environmental impact of dentistry, students would be better informed and able to make more environmentally conscious decisions as emerging oral healthcare professionals.

## Conclusions

Students are environmentally aware and conscious of the impact that the provision of oral healthcare has on the environment. They recognise the importance of the need for the 'qualified/practising' profession to engage in this topic to mitigate its impacts. There is a clear recognition that ESD is not consistently taught in the undergraduate curriculum in dental schools across the UK. In this context, they also identify that the inclusion of such a topic into their already congested curricula could present a problem, putting greater demands on their learning and progression. They positively identify the is a need for schools to include ESD in the student curricula in a seamless and fully integrated manner so that it does not create a further burden to learning and teaching.

Students identify the need for educational institutions, dental schools and dental hospitals working collaboratively, to engage further to include environmental sustainability in the undergraduate curricula as part of the core learning and teaching.

## Declaration of interests

The authors declare that they have no conflict of interest.

## Author contributions

Conceptualisation: Steven Mulligan and Nicolas Martin; Project design: Steven Mulligan, Nicolas Martin, Olivia Durnall and Jonathan Dixon; Project execution: Olivia Durnall, Steven Mulligan, Jonathan Dixon and Nicolas Martin; Initial writing: Olivia Durnall and Steven Mulligan; Results and interpretation of data: Steven Mulligan, Nicolas Martin, Olivia Durnall and Jonathan Dixon; Final writing and editing: Nicolas Martin, Olivia Durnall and Jonathan Dixon.

## Acknowledgement

The authors thank the UK Dental Schools Council for supporting this study with proactive dissemination of the survey amongst its member institutions. We thank the individual deans and heads of departments for further promoting this study within their own institutions and we express our sincere gratitude to the actual student respondents for their active and willing participation.

## Corresponding Author

Olivia Durnall: oliviadurnall@gmail.com

## References;

1. National Geographic Society. Anthropocene. Available from: <https://education.nationalgeographic.org/resource/anthropocene> [Accessed: 12/12/2022]
2. Rafferty J. The Rise of the Machines: Pros and Cons of the Industrial Revolution. Encyclopedia Britannica. 2017. Available from: <https://www.britannica.com/story/the-rise-of-the-machines-pros-and-cons-of-the-industrial-revolution> [Accessed: 12/12/2022]
3. Allen W.M., Dube O.P., Solecki W., Aragón-Durand F., Cramer W., Humphreys S., Kainuma M., Kala J., Mahowald N., Mulugetta Y, Perez R., Wairiu M. ZK. Framing and context supplementary material. In: Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels And Related Global Greenhouse Gas Emission Pathways. 2018. Available from: <https://www.ipcc.ch/sr15/> [Accessed: 12.12.2022]
4. Organisation WH. COP26 special report on climate change and health: the health argument for climate action. Geneva. World Health Organization; 2021. Available from: <https://apps.who.int/iris/rest/bitstreams/1378263/retrieve> [Accessed: 10/12/2022]
5. Prescription HC. Healthy Climate Prescription. An urgent call for climate action from the health community ahead of COP26. 2021. Available from: <https://healthyclimateletter.net/> [Accessed: 10/12/2022]
6. Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Belesova K, Boykoff M, et al. The 2019 report of The Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. *Lancet*. 2019 Nov 16;394(10211):1836–78. doi: 10.1016/S0140-6736(19)32596-6. PMID: 31733928.
7. Karliner J, Slotterback S, Boyd R, Ashby B, Steele K. Health Care's Climate Footprint: How the health sector contributes to the global climate crisis and opportunities for action. *Health Care Without Harm; Climate-smart health care series Green Paper Number One. Heal Care Without Harm*. 2019;(September):1–48. Available from: [https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint\\_092319.pdf](https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf) [Accessed:13/08/2023]
8. Duane B, Stancliffe R, Miller FA, Sherman J, Pasdeki-Clewer E. Sustainability in Dentistry: A Multifaceted Approach Needed. *J Dent Res*. 2020 Aug;99(9):998-1003. doi: 10.1177/0022034520919391. Epub 2020 May 11. PMID: 32392435.
9. Sustainability (Special Edition). *J Am Col Dent*. 2018;85 (3)(1–44).
10. Martin N, Mulligan S, Shellard IJ and Hatton PV. Consensus on Environmentally Sustainable Oral Healthcare: A Joint Stakeholder Statement. York: White Rose University Press 2022. DOI: <https://doi.org/10.22599/OralHealth> [Accessed: 12/08/2023]

11. Wilson GJ, Shah S, Pugh H. What impact is dentistry having on the environment and how can dentistry lead the way? *Fac Dent J*. 2020;11(3):110–3.
12. Duane B, Lee MB, White S, Stancliffe R, Steinbach I. An estimated carbon footprint of NHS primary dental care within England. How can dentistry be more environmentally sustainable? *Br Dent J*. 2017;223(8):589–93. Available from: <http://dx.doi.org/10.1038/sj.bdj.2017.839> [Accessed: 12/12/2022]
13. Mulligan S, Kakonyi G, Moharamzadeh K, Thornton SF, Martin N. The environmental impact of dental amalgam and resin-based composite materials. *Br Dent J*. 2018;224(7):542–8.
14. Martin N, Sheppard M, Gorasia G, Arora P, Cooper M, Mulligan S. Awareness and barriers to sustainability in dentistry: A scoping review. *J Dent*. 2021 Sep;112:103735. doi: 10.1016/j.jdent.2021.103735. Epub 2021 Jun 25. PMID: 34182058. Martin N, Martin
15. N, Sheppard M, Gorasia G, Arora P, Cooper M, Mulligan S. Drivers, opportunities and best practice for sustainability in dentistry: A scoping review. *J Dent*. 2021 Sep;112:103737. doi: 10.1016/j.jdent.2021.103737. Epub 2021 Jun 26. PMID: 34182061.
16. Martin N, Smith L, Mulligan S. Sustainable oral healthcare and the environment: Mitigation strategies. *Dent Update*. 2021;48(7):524–31.
17. Martin N, Smith L, Mulligan S. Sustainable oral healthcare and the environment: Challenges. *Dent Update*. 2021;48(7):524–31.
18. Duane B, Dixon J, Ambibola G, Aldana C, Coughlan J, Henao D, Daniela T, Veiga N, Martin N, Darragh J-H, et al. Embedding environmental sustainability within the modern dental curriculum— Exploring current practice and developing a shared understanding. *Eur J Dent Educ*. 2021;25(3):541–9.
19. NUS Green Impact. <https://www.greenimpact.org.uk/dentists>. [Accessed 09 August 2023]
20. Field J, Martin N, Duane B, Vital S, Mulligan S, Livny A, Lindberg P, Gummesson C, Long R, Lundbeck H, et al. Embedding environmental sustainability within oral health professional curricula—Recommendations for teaching and assessment of learning outcomes. *Eur J Dent Educ*. 2022;
21. Duane B, Lee MB, White S, Stancliffe R, Steinbach I, Mulligan S, et al. Sustainable oral healthcare and the environment: Mitigation strategies. *Br Dent J* [Internet]. 2021;112(7):524–31. Available from: <https://doi.org/10.1016/j.jdent.2021.103735>
22. Martin N, Mulligan S. Environmental Sustainability Through Good-Quality Oral Healthcare. *Int Dent J*. 2021;0:1–5.
23. James Field, Jonathon Dixon, Julia Davies, Barry Quinn, Denis Murphy, Sibylle Vital, Corrado Paganelli, Ilze Akota, Gabor Gerber, Valerie Roger-Leroi, Maria Cristina Manzanares-Cespedes STJ. O-Health-Edu: A vision for oral health professional education in Europe. *Eur J Dent Educ*. 2023;27: 382–38.
24. (ADEE) A for DE in E. SIG: Sustainability in Dental Education | ADEE - Association for Dental Education in Europe. Available from: <https://adee.org/sig-sustainability-dental-education> [Accessed: 12/12/2022]
25. Joury E, Lee J, Parchure A, Mortimer F, Park S, Pine C, Ramasubbu D, Hillman L. Exploring environmental sustainability in UK and US dental curricula and related barriers and enablers: a cross-sectional survey in two dental schools. *Br Dent J*. 2021 May;230(9):605–610. doi: 10.1038/s41415-021-2942-y. Epub 2021 May 14. PMID: 33990748.
26. Gershberg NC, Lee J, Murphree JK, Parchure A, Hackley DM. US students' perceptions on environmental sustainability in dental school. *J Dent Educ*. 2022 Apr;86(4):482–488. doi: 10.1002/jdd.12824. Epub 2021 Nov 15. PMID: 34780059.
27. Council DS. Dental Schools Council - The principal source of informed opinion and advice on education and research in dental schools in the United Kingdom and Ireland. Available from: <https://www.dentalschoolscouncil.ac.uk/> [Accessed: 12/08/2023]
28. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77–101.
29. Medical News Today. Eco-anxiety; 75% of young people say the future is frightening. 2021. Available from: <https://www.medicalnewstoday.com/articles/eco-anxiety-75-of-young-people-say-the-future-is-frightening#A-generation-betrayed> [Accessed: 12/12/2022]
30. Clayton S, Manning C, Krygsman K, Speiser M. Mental health and our changing climate: Impacts, implications, and guidance. Washington, DC: American Psychological Association and ecoAmerica. 2017 Mar.
31. Hickman C. We need to (find a way to) talk about ... Eco-anxiety. *J Soc Work Pract*. 2020;34(4):411–24. Available from: <https://doi.org/10.1080/02650533.2020.1844166> [Accessed: 24/03/2023]

32. Nations U. #YouthStats: Environment and Climate Change. 2015. Available from: <https://www.un.org/youthenvoy/environment-climate-change/> [Accessed: 12/12/2022]
33. GOV.UK. Over 80% of young people eager to take action to help the environment. 2021. Available from: <https://www.gov.uk/government/news/over-80-of-young-people-eager-to-take-action-to-help-the-environment> [Accessed: 12/12/2022]
34. FDI World Dental Federation. Sustainability Award. 2022. Available from: <https://sustainability-platform.fdiworlddental.org/sustainability-award> [Accessed: 12/12/22]
35. FDI World Dental Federation. Sustainability in Dentistry. 2023. Available from: <https://www.fdiworlddental.org/sustainability-dentistry> [Accessed: 09/08/2023]

## Appendix

Table 1 - Understand student's level of concern about the environment	
To what extent are you concerned about your own impact on the environment in everyday life?	
Very concerned	46 (17.5%)
Concerned	172 (65.4%)
Not very concerned	33 (12.5%)
Never thought about it	12 (4.6%)
To what extent do you try to reduce the environmental impact of your daily activities?	
I always try	71 (27%)
I sometimes try	142 (54%)
I would like to do more but don't know how	42 (16%)
I don't really try	7 (2.7%)
Not my problem, it is the responsibility of the authorities and government	1 (0.4%)
Have you considered if the provision of oral healthcare has an impact on the environment?	
Yes	237 (90.1%)
No	26 (9.9%)
With regards to the last question, please read the following carefully and tick all that apply;	
The environmental impact is negligible and can be ignored.	3 (1.1%)
Society has bigger environmental problems to worry about that should focus or attention.	38 (14.4%)
The provision of oral healthcare is my priority as a clinician and this has unavoidable environmental consequences that we need accept.	122 (46.4%)
As clinical oral healthcare workers we have enough to worry about; our job is hard enough and sustainability concerns are not part of our job.	16 (6.1%)
It is our responsibility, as oral healthcare workers, to provide care in an environmentally sustainable manner.	225 (85.6%)
How concerned are you about the effect of oral healthcare on the environment?	

Unconcerned	4 (1.5%)
Neither	57 (21.7%)
Concerned	202 (76.8%)

**Table 2 - Understand student's level of awareness of the impact that oral healthcare provision has on the environment**

Have you considered if the provision of oral healthcare has an impact on the environment?	
Yes	237 (90.1%)
No	26 (9.9%)
With regards to the last question, please read the following carefully and tick all that apply;	
The environmental impact is negligible and can be ignored.	3 (1.1%)
Society has bigger environmental problems to worry about that should focus or attention.	38 (14.4%)
The provision of oral healthcare is my priority as a clinician and this has unavoidable environmental consequences that we need accept.	122 (46.4%)
As clinical oral healthcare workers we have enough to worry about; our job is hard enough and sustainability concerns are not part of our job.	16 (6.1%)
It is our responsibility, as oral healthcare workers, to provide care in an environmentally sustainable manner.	225 (85.6%)
How concerned are you about the effect of oral healthcare on the environment?	
Unconcerned	4 (1.5%)
Neither	57 (21.7%)
Concerned	202 (76.8%)

**Table 3 - Identify if student environmental concern are a driver for inclusion of environmental sustainability in the UG curriculum**

Do you think that the dental profession should be more actively engaged in environmental sustainability?	
Yes	256 (97.3%)
No	7 (2.7%)
During your undergraduate degree, have you been exposed to the concept of environmental sustainability? Please tick all that apply;	
Never exposed	62 (23.6%)
Formal lecture's	24 (9.1%)
Briefly mentioned by staff members	134 (51%)
Students society talks/activities	46 (17.5%)
Informal conversations between peers/friends	140 (53.2%)

Would you like your undergraduate dental course to include a greater emphasis on environmental sustainability?	
Yes	223 (84.8%)
No	40 (15.2%)
Have you personally or as part of a group, ever taken a pro-active approach to learning about oral healthcare and its environmental impact?	
Yes	62 (23.6%)
No	201 (76.4%)
How do you think that we can increase awareness of the impact that oral healthcare provision on the environment within the undergraduate curriculum?	
Through social media	174 (66.2%)
Professional talks	197 (74.9%)
Student led societies	121 (46%)
BDSA	139 (52.9%)
Tutor facilitated group tutorials	155 (58.9%)
Do you think that increasing our knowledge of environmental sustainability in oral healthcare will have an impact on our future profession and the environment?	
Huge positive impact	84 (31.9%)
Some positive impact	173 (65.8%)
No impact	6 (2.3%)
Negative impact	0 (0%)



# Figures

Figure 1:

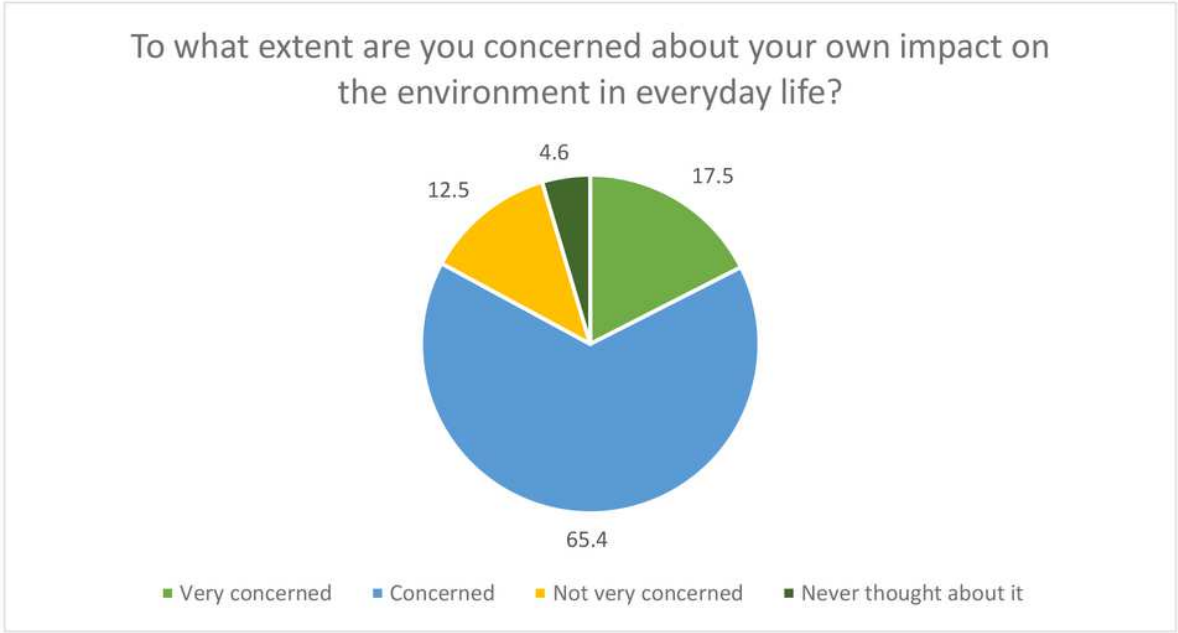


Figure 1  
Responses demonstrate the level of concern students express towards environmental sustainability in everyday life.

Figure 1

Legend not included with this version

Figure 2:

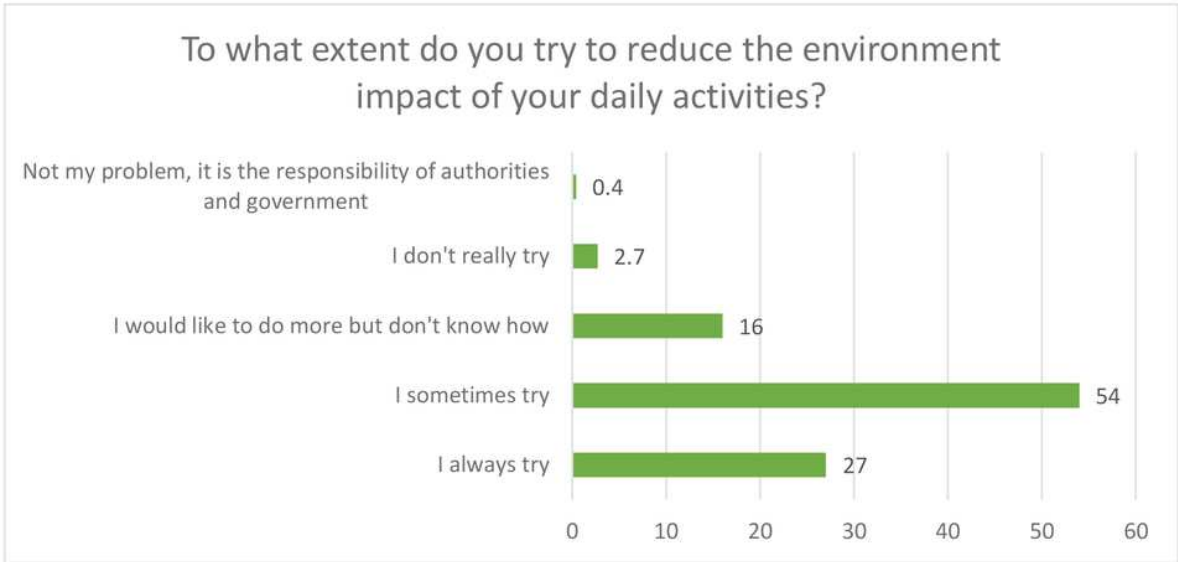


Figure 2  
Results identify students' current level of proactivity regarding reducing their personal impact on the environment.

Figure 2

Legend not included with this version

Figure 3:

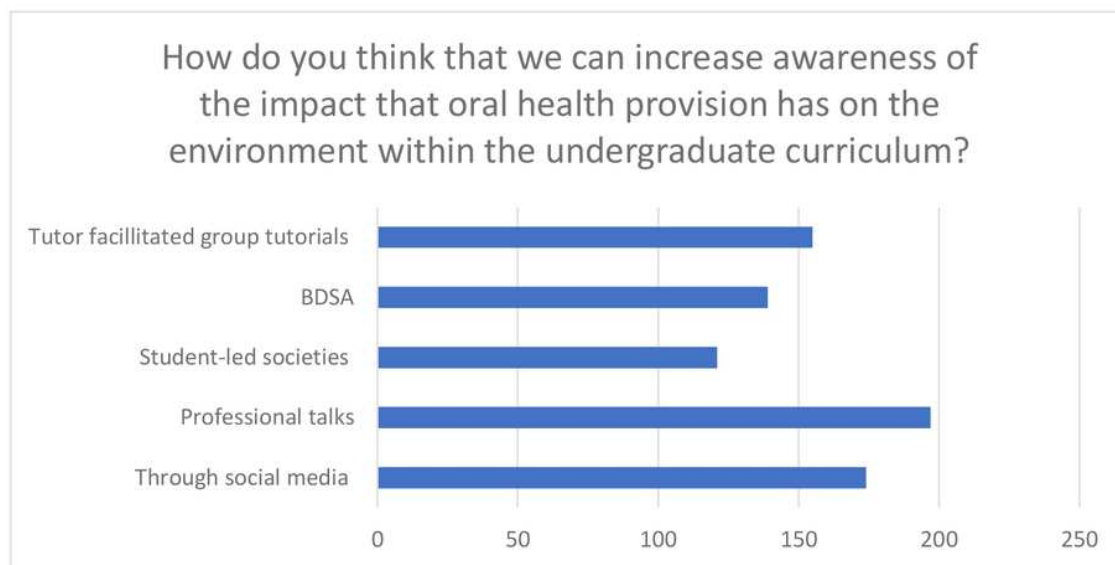


Figure 3;  
97.3% of students believe that the dental profession should be more actively engaged with environmental sustainability.

Figure 3

Legend not included with this version

**Figure 4:**



**Figure 4;**

Students identified social media, professional talks and tutor-led discussions as the best way to increase awareness of the impact that oral health provision has on the environment.

**Figure 4**

Legend not included with this version