

## Journal Pre-proof

Curriculum Content for Environmental Sustainability in Dentistry

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PII: S0300-5712(24)00191-X  
DOI: <https://doi.org/10.1016/j.jdent.2024.105021>  
Reference: JJOD 105021

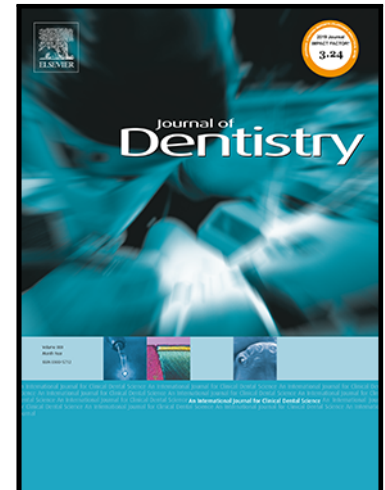
To appear in: *Journal of Dentistry*

Received date: 7 March 2024  
Revised date: 20 April 2024  
Accepted date: 23 April 2024

Please cite this article as: Jonathan Dixon , James Field , Emma Gibson , Nicolas Martin , Curriculum Content for Environmental Sustainability in Dentistry, *Journal of Dentistry* (2024), doi: <https://doi.org/10.1016/j.jdent.2024.105021>

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### Highlights

- There is an urgent need to embed Environmental Sustainability in dental education.
- A comprehensive strategy to embed Environmental Sustainability in the curriculum.
- A novel method to define and map curriculum content has been explored and validated.
- Defined a list of educational content statements for Environmental Sustainability.
- Statements mapped to all curriculum subjects to facilitate teaching and assessment.

Journal Pre-proof

# Curriculum Content for Environmental Sustainability in Dentistry

Short Title: Curriculum Content for Environmental Sustainability in Dentistry

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Keywords: Environmental Sustainability, Dental Education, Curriculum Content, Oral Health Professionals, Dental Hygienists

## Abstract

*Objectives:* (i) Identify suitable strategies and opportunities to embed Environmental Sustainability (ES) within an existing Oral Health Professional (OHP) curriculum through a series of focus groups with students and academic staff and (ii) Create high-level evidence-based and subject-specific ES content through an approach grounded in evidence and collaboration with key stakeholders in OHP education.

*Methods:* Focus groups were used to explore academic staff and student views on appropriate teaching and assessment methods for ES. Content statements were developed from an extensive literature search, mapped to curriculum subjects, and validated through consultation with students, discipline-experts and education-experts.

*Results:* Five themes were identified from the focus groups: Environmental Sustainability transcends all disciplines of dentistry and oral healthcare; Baseline knowledge transmission with relevant practical application; Viewing and modifying existing teaching and assessment events through a different lens; Normalising the topic of Environmental Sustainability to support attitude and behaviour change and Safeguarding against misinformation and disinformation. Forty-four content statements were developed and mapped to nineteen curriculum subjects.

*Conclusions:* This study identifies for the first time a comprehensive strategy for the inclusion and delivery of ES (method and content) in the curriculum. A novel method to define and map curriculum content has been explored and validated using a range of complementary methodologies. A comprehensive and robust list of evidence-based and subject-specific educational content statements have been defined in the field of Environmental Sustainability in dentistry and oral healthcare.

*Clinical Significance:* Oral healthcare has a significant environmental impact, the key to all mitigation strategies is by educating the profession at all levels.

Keywords: Environmental Sustainability, Dental Education, Curriculum Content, Oral Health Professionals, Dental Hygienists

## Introduction

Oral Health Professional (OHP) curricula must be responsive to the changing societal and educational landscape to ensure graduates can meet the demands of the profession for the present and the future. As a regular quality assurance measure, a curriculum should have in-built sustainability achieved through a development process to allow appropriate periodic review of material content and delivery [1, 2]. Curricula typically develop over time in response to three principal drivers: new developments in the discipline (dentistry and oral healthcare), changing educational rationales and innovation and pressures from wider stakeholders [3-8].

Environmental Sustainability (ES) and climate change are challenges that transcend all sectors. The United Nations Brundtland Commission defined Sustainability as: "*Meeting the needs of the present without compromising the ability of future generations to meet their own needs*" [9]. The significant environmental impact of oral healthcare, particularly in relation to carbon dioxide equivalent emissions, pollution and waste generation has been highlighted and quantified in the literature [10-12]. These impacts principally relate to staff commute, patient travel, procurement, energy and water consumption and waste generation.

### Introducing ES into OHP education

The need to embed ES within OHP education at all levels (undergraduate, postgraduate, and continuing professional development) has been established [13-16]. The Association for Dental Education in Europe (ADEE) has been at the forefront of this drive with the 'Sustainability in Dentistry' Special Interest Group activities reported in two published consensus reports [13, 14]. These reports (i) identify the need to embed ES within the OHP curriculum and (ii) recommend learning outcomes and methods of learning, teaching, and assessment of ES. Similarly, the FDI World Dental Federation is actively promoting ES through education in all settings with a wide range of impactful resources and publications [16-19]. Staff and student support for introduction of the topic into undergraduate education has been demonstrated in multiple surveys [20-23].

An example of implementation at a national level is the General Dental Council in the United Kingdom (UK). The regulator has adopted some learning outcomes from the ADEE European consensus report in the recent Safe Practitioner Framework publication [24]. This mandates that ES is taught and assessed in UK dental schools from September 2025 and that all graduates must demonstrate that they meet the learning outcomes from 2030.

### The challenges with introducing ES

Higher Education Institutions across the world are cognisant of the need to embed ES education across all their departments, including dental schools. This task presents a number of real challenges in OHP education, and it appears that many schools are not currently teaching or assessing ES, as identified in a recent pan-European survey [25]. The profession has sought to address this deficit with the publication of guidance and recommendations that address the conceptual implementation challenges [13, 14]. The ADEE consensus statements remain the only guidance for educators in OHP education with respect to ES. The documents promote ES and establish a need, as well as proposing learning outcomes to be taught and assessed. Notwithstanding, several practical barriers remain to embed and implement ES in the undergraduate dental curriculum [21, 22, 26], that include:

- A perceived lack of knowledge to teach ES.
- Time constraints due to the overloaded nature of existing curricula.
- A lack of practical guidance and resources for educators and students.

The aims of this research are two-fold:

Identify suitable strategies and opportunities to embed ES within an existing curriculum through a series of focus groups with OHP students and academic staff.

Create high-level evidence-based and subject-specific ES content through an approach grounded in collaboration with key stakeholders in OHP education.

The objectives to meet these aims are:

To explore the opinions of academic staff and students on strategies to teach and assess selected ES learning outcomes within undergraduate OHP curricula.

To create, categorise and map evidence-based and subject-specific content statements.

To undertake a stakeholder consultation to ensure that the content statements are fit for purpose.

## Materials and Methods

The aims and objectives were achieved through two exploratory investigations:

- Workstream 1: Explore the Views of Academic Staff and Students to Embedding Environmental Sustainability in the Curriculum - A Qualitative Approach
- Workstream 2: Develop and Map Content Statements for Environmental Sustainability to Subjects within the Dental Curriculum - A Multi-Stakeholder Consultation

Explore the Views of Academic Staff and Students to Embedding Environmental Sustainability in the Curriculum - A Qualitative Approach

This intervention received approval from the Dentistry Ethics Committee at the lead author's affiliated institution (application number 056582). Focus groups were used to achieve the aims of this research.

### Recruitment

Academic teaching staff (clinical and non-clinical) across all departments of the authors' academic institutions and students registered on undergraduate clinical programmes (Bachelor's Degree in Dentistry Surgery and Diploma in Dental Hygiene and Dental Therapy) were invited to participate in the study. The email invitation provided an overview of the project, proposed focus group dates and a more detailed participant information sheet. Interested participants were asked to respond by email to confirm their interest and availability. Additional recruitment measures were considered with provision to extend the focus group study if data saturation was not accomplished. All participants gave consent and clarity was provided regarding withdrawal of consent.

### Structure of the intervention

Forty-five-minute focus group meetings were undertaken across multiple days between December 2023 and January 2024. Participants were grouped either as academic staff or students, there was no mixing amongst cohorts. Focus group sizes were limited to four and five participants. One experienced focus group facilitator (JD) chaired all the sessions having completed the required training. The focus groups were semi-structured, with a prepared script used to guide the facilitator to ensure reproducibility across all interventions. The script was developed from published research relating to curriculum development in OHP education [14, 27, 28]. The discussion centred around three learning outcomes taken from the ADEE learning outcomes publication, with participants asked to propose methods to teach and assess or observe each statement [14].

The three learning outcomes used were:

Explain the importance of practising sustainable oral health care.  
 Apply the scientific knowledge base in relation to the environmental impacts of common treatment methods, and common approaches to the delivery of care.  
 Develop effective patient-specific strategies for preventive oral health, reducing the need for recall, operative intervention, and material use.

### Data collection

The focus group discussion content was transcribed live by a trained researcher (EG) using Google Docs (<https://www.google.co.uk/docs/about/#overview>). Each focus group discussion was also audio-recorded and used to supplement the transcriptions where appropriate. The interactive presentation platform 'Woo Clap' (<https://www.wooclap.com/>) was used to gather independent thoughts that served as points of discussion for all attendees. During the discussions, participants were given codes that conferred anonymity and enabled effective matching and collation of statements.

### Data analysis

Independent responses to the questions and the written transcriptions were analysed by two independent and trained assessors (JD, EG) using thematic analysis as described by Braun and Clarke [29]. The preliminary steps were completed independently and included data familiarisation, coding, and theme development. The two assessors then met to reach consensus through discussion and if needed, re-evaluation of the transcripts. In this analytical approach, themes are created according to perceived relevance to the research question and not necessarily the prevalence of topics. Data saturation was determined when no new themes were identified in the transcripts.

## Develop and Map Content Statements for Environmental Sustainability to Subjects within the Dental Curriculum - A Multi-Stakeholder Consultation.

Prior to development, the conceptualisation of this project was shared with academic staff and students to identify any early issues with feasibility and acceptability. The development and refinement of content statements followed five steps.

### 1. Identification of core sources

The evidence base for ES in oral healthcare was gathered through an extensive literature search that ran continuously from August 2021 to January 2024 to ensure all contemporaneous literature (English language) was included in the research. The search strategy was dynamic and evolved depending on the area of interest. The MEDLINE database was used to identify relevant sources and MeSH keywords were used. The core search terms used were:

- [Title]: sustain\* AND dent\*
- [Title]: sustain\* AND oral
- [Title]: environ\* AND dent\*
- [Title]: environ\* AND oral
- [Title]: eco\* AND dent\*
- [Title]: eco\* AND oral
- [Title]: green AND dent\*
- [Title]: green AND oral
- [Title/Abstract]: climate AND dent\*
- [Title/Abstract]: climate AND oral
- [Title/Abstract]: life cycle AND dent\*
- [Title/Abstract]: life cycle AND oral

- [Title/Abstract]: planet\* AND dent\*
- [Title/Abstract]: planet\* AND oral
- [Title/Abstract]: waste AND environ\* AND dent\*
- [Title/Abstract]: waste AND environ\* AND oral

There were no date limitations to the search strategy and all published articles that were relevant to the subject area were included.

## 2. Theme generation and organisation

Themes relevant to ES in oral healthcare were identified from the literature search. This process allowed the researchers to organise the subject area prior to writing the evidence-based statements.

## 3. Content statement development

The content statements were written and refined by three researchers (JD, NM, JF) who were led by the evidence base, and the themes generated from the previous steps. The researchers used their expert opinion in relation to ES and curriculum development to devise the statements with a pedagogic structure. This was an iterative process whereby researchers developed and refined multiple drafts through discussion until consensus was reached.

## 4. Identification of curriculum subjects/disciplines and mapping the content statements

A list of curriculum subjects was developed from the EU directive 2005/36/EC and national specialty bodies [30]; these were: Basic Sciences, Cariology, Periodontology, Endodontology, Paediatric Dentistry, Preventive Dentistry, Conservative Dentistry, Prosthetic Dentistry, Orthodontics, Oral and Maxillofacial Surgery, Oral Medicine and Pathology, Oral and Maxillofacial Radiology and Imaging, Oral Implantology, Special Care Dentistry, Dental Public Health and Community Dentistry, Dental Biomaterials, Dental Technology, Ethics, Professionalism, Information Literacy, Social Accountability and Behavioural Sciences, Dental Practice Management.

Each content statement was mapped to the relevant curriculum subjects by two independent researchers (JD, NM) through multiple rounds of discussion. Any disagreements were resolved through consultation with an additional researcher (JF).

## 5. Consultation process

To ensure the evidence-based and subject-specific statements were fit for purpose across relevant stakeholders in OHP education, three separate consultation processes were undertaken with three different cohorts: students, discipline-experts, and education-experts.

The student consultation process was developed to review the clarity of language and ease-of understanding of the content statements. Clinical students from two dental schools in the UK were invited to comment. A Google Forms (<https://docs.google.com/forms>) survey link was created that included all content statements and a dichotomous answer of 'clear' and 'not clear' for each statement. All questions were mandatory with a further free-text option to comment on the 'not clear' responses.

The discipline-expert consultation process aimed to validate the mapping of content statements carried out by the researchers previously. Discipline experts from participating dental schools in the UK were invited to contribute to this process. Academics who teach these disciplines were invited to comment on the statements that were mapped to their area of expertise.

The final consultation process was disseminated through ADEE with the aim of acquiring the views of educationalists from across Europe. A consultation page was created on the ADEE website whereby the content statements and subject mapping were presented. Respondents were asked to provide their comments via a free-text box. The consultation process was shared in ADEE's monthly newsletter and via social media.

Comments from all three consultation processes were used to refine the content statements to ensure clarity of language and educational validity.

## Results

### Explore the Views of Academic Staff and Students to Embedding Environmental Sustainability in the Curriculum - A Qualitative Approach

A total of forty participants attended the focus groups, with a split of twenty-two academic staff and eighteen students from 8th December 2023 to 19th January 2024. Academic staff participants included academics from nine different curriculum subjects and ranged from clinical teachers (part-time clinicians) to professors. Students from both the undergraduate dental surgery and dental hygiene and dental therapy clinical programmes participated in the research, ranging from first year to final year students. Data saturation was reached in the sixth focus group and after twenty-eight participants, obviating the need to extend the study beyond the planned interventions. All planned and scheduled focus groups were conducted, even after data saturation had been achieved; to ensure inclusivity of all views.

Thematic analysis of the transcriptions from the focus groups resulted in the generation of five themes. The themes and supporting quotes are presented in Table 1.

**Table 1:** Themes identified through thematic analysis and supporting quote(s) from the focus group sessions.

Theme	Supporting Quote(s)
Normalising the topic of Environmental Sustainability to support attitude and behaviour change.	<i>"It should be mentioned in most lectures, so students automatically think about Environmental Sustainability." "It must be seen as a normal part of their practice on a daily basis and not a separate thing."</i>
Baseline knowledge transmission with relevant practical application.	<i>"It should be reinforced practically, and I think it should be embedded as you go through your course, not just a lecture on Environmental Sustainability and you are expected to know it."</i>
Viewing and modifying existing teaching and assessment events through a different lens.	<i>"It is a lens issue, we need to change our language." "It could be something as simple as modifying the patient management marking scheme to include Environmental Sustainability."</i>
Environmental Sustainability transcends all disciplines of dentistry and oral healthcare.	<i>"Students need to see the importance of Environmental Sustainability in every area of dentistry. Every educator needs to be thinking about Sustainability in their teaching."</i>
Safeguarding against misinformation and disinformation.	<i>"It is important that students know about life-cycle assessments (LCA's) to provide evidence-based facts and avoid disinformation."</i>















































own environmental impacts from the surgical care, equipment, sterilisation, single use plastics and waste.

These investigations have achieved the aims of identifying suitable strategies to embed ES within an existing curriculum and creating evidence-based and subject-specific ES content. The focus groups included a significant number of academic staff and students and the consultation process for the evidence-based statements included views from three key stakeholders of OHP education. A potential limitation of this study is the acceptance of probable selection bias of participants within the focus groups and the consultation process. That is, despite a participant selection process that actively encouraged inclusivity and diversity of opinions; it is likely that study participants self-selected by virtue of their inherent interest in the subject. This is not necessarily considered to be a drawback in this study as the participant's interest (and bias) towards the subject enabled the acquisition of a comprehensive range of strategies and content statements for the inclusion of ES in the curriculum. Additionally, whilst the authors acknowledge that the use of flow chart is useful to present the findings of the literature searches, this was not possible due to the extensive date range of the literature search that spanned several years.

There is an acknowledgement of wide health inequalities across the world, both within countries and across borders. For the oral healthcare profession, this presents a real challenge with a need to balance preventive oral healthcare with sustainability goals [16]. Moreover, the evidence that supports our current understanding of the perceived educational challenges and the proposed solutions, arise from a relatively small number of higher education institutions [21-23]. It is important therefore, that the strategic educational approaches and content that are promoted in this document are considered in the cultural and socio-economic contextual framework of the region in which they are to be implemented.

## Conclusions

There is an urgent need to include Environmental Sustainability in the education of Oral Health Professionals at all stages, from early undergraduate to postgraduate continuing professional development. This study identifies for the first time a comprehensive strategy for the inclusion and delivery of ES (method and content) in the curriculum. A novel method to define and map curriculum content has been explored and validated using a range of complementary methodologies. A comprehensive and robust list of evidence-based and subject-specific educational content statements have been defined in the field of Environmental Sustainability in dentistry and oral healthcare. These statements have been mapped to all curriculum subjects and it is envisaged that these can be adopted and integrated by educators into the existing curriculum, without the need to disrupt the core syllabus and course structure.

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**Declaration of interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The author is an Editorial Board Member/Editor-in-Chief/Associate Editor/Guest Editor for [*Journal name*] and was not involved in the editorial review or the decision to publish this article.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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