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# Developing a Prosthodontic Curriculum for Graduating European Dentists

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## ABSTRACT

**Aim:** This paper presents peer-reviewed undergraduate curriculum guidelines for indirect restorations and prosthodontics.

**Background:** Prosthodontics teaching represents a significant part of Dental Undergraduate education. Despite the publication of European undergraduate curriculum guidelines in other fields, none exist for Prosthodontics. In 2023 the British Society of Prosthodontics (BSSPD) formed a working group to develop undergraduate curriculum guidelines specifically for indirect restorations and prosthodontics.

**Methodology:** Learning outcomes (LOs) and competences were developed following the Association of Dental Education in Europe (ADEE) Graduating European Dentist guidance. Four capability domains were formed: (1) Knowledge of the scientific and evidence-base; (2) General prosthodontics; (3) Indirect restorations; and (4) Removable prosthodontics. To achieve agreement for the structure and content, a modified-Delphi approach was employed. This aimed to identify the clarity (clear/not clear), importance (essential/important/aspirational) and difficulty to teach (easier/more difficult to teach) for each LO.

**Results:** Agreement for LO clarity, importance and difficulty was achieved: 100% were 'clear'; 95% were 'essential', 5% were 'important' and none were 'aspirational'; 73% were 'easier to teach' and 27% were 'more difficult to teach'. The finalised guidelines contain 16 competencies and 90 LOs. LOs are classed as *fundamental* (assessable through discussion or written assessment), *supporting clinical* (directly observable within a clinical or skills environment, or through case-based discussion or written assessment), *or clinical* (directly observable within a clinical or skills environment) to assist implementation.

**Conclusion:** Final consensus was reached for all LOs following the combined survey and in-person consultation process. A novel categorisation of LO supports educators to build these into existing curricula.

## 1 | Introduction

Over the last three decades there has been a move to provide competency-based curriculum guidance to progress and standardise dental undergraduate curricula in Europe [1, 2]. Competency, a professional construct, relates to the development of professional behaviours and skills to respond to the full range of circumstances encountered in general professional practice [2]. In order to develop competence within the educational setting, individual and objective behaviour-based learning outcomes (LOs) (an educational construct) are widely accepted to guide curriculum design, teaching, and assessment.

European curriculum documents outlining undergraduate competences and LOs that support the Association of Dental Education Europe (ADEE) Graduating European Dentist have been developed and published in the fields of implant dentistry (2009), gerodontology (2009), periodontology (2010

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and 2024), cariology (2011), oral medicine (2012 and 2018), endodontology (2013), and special care dentistry (2014) [3–11]. These documents have helped address the divergence in dental undergraduate curricula that has previously been reported within the UK and Europe [12–14]. There is currently no modern curriculum guidance available for undergraduate prosthodontic education, despite evidence that variability in prosthodontic teaching exists [12, 15–18]. The aim of this paper is to present new curriculum guidance for indirect restorations and prosthodontics and describe the way in which it was developed.

### 1.1 | Educational Background

The World Health Organisation's (WHO) Global Strategy and Action Plan on Oral Health 2023–2030 was developed to achieve resolution of oral health. One of their 6 strategic objectives is to 'develop innovative workforce models and revise and expand competency-based education to respond to population oral health needs' [19].

The strategy emphasised the need to improve oral health workforce curricula and training (action 49) and improve oral health training and accreditation (action 56) by introducing competency-based learning to promote mutual recognition of professional qualifications and enable free movement of oral health professionals [19]. In 2017, the ADEE published five curriculum papers, collectively titled The Graduating European Dentist (GED), with the initial introductory paper providing context and rationale for the learning-outcomes-based approach [2]. These strategic educational publications support competency-based and LO-based curricula for dental education, reinforcing the need for a similar approach for indirect restorations and prosthodontic undergraduate education.

The most recent Curriculum Framework for the GED published by the ADEE establishes updated objectives to support dental education and training. The methodology followed, and framework developed, within this curriculum document aims to satisfy the current GED objectives:

- Define the curriculum with explicit behaviour-based 'Learning Outcomes'.
- Encourage the utilisation of existing and contemporaneous curricula, published by specialist societies and organisations, as a basis from which to develop or formulate local curricula.
- Include methods of learning and methods of assessment.
- Update the methods of quality assurance for the delivery of undergraduate dental education and training [2].

When developing new LOs, stakeholder collaboration and consensus-based methodologies are considered good practice [20, 21]. A recent Delphi consensus by Khalaf et al. agreed 'important' teaching and assessment methods for an undergraduate prosthodontic curriculum [22]. An enhanced approach to LO design has been recommended by Field et al. and Dixon et al. considering LO *clarity*, LO *importance* (essential, important or aspirational) and LO *difficulty to teach or assess*, as well as defining a specific statement describing what a student will be able to know, understand, and/or do by the end of a teaching event [23, 24].

### 1.2 | Objectives

The objectives to create curriculum guidance for indirect restorations and prosthodontics included:

1. Convene a working group to:
   a. Review existing literature, guidelines and recommendations, and identify the necessary educational objectives of a dental undergraduate curriculum for indirect restorations and prosthodontics.
   b. Develop a contemporary list of LOs and competencies for an indirect restorations and prosthodontics curriculum.
   c. Suggest appropriate methods of clinical assessment and educational environments for the teaching and assessment of each LO.
2. Conduct an open stakeholder approach (modified-Delphi process) to quantify the level of agreement for the *clarity*, *importance* and *difficulty to teach* for each LO within the curriculum guidance [23].

## 2 | Methodology

### 2.1 | Draft Curriculum Guidelines

A working group of four members was convened through the British Society for Prosthodontics (BSSPD) whose remit was to develop a series of LOs and competencies to be included in a comprehensive undergraduate curriculum for a graduating dentist. The effort to define a series of LOs for a core prosthodontic curriculum included the following stages:

1. A detailed literature search of journal articles, educational guidelines and organisation publications which purported to address undergraduate Prosthodontic education [22–24].
2. Generation of a list of LOs and competencies.
3. Near-peer review of the list of LOs and competencies.
4. Categorisation of the apparent core capability domains.
5. Review of the pedagogical structure of the LOs and competencies to meet the most recent educational guidance [23, 24].
6. Review and agreement on the final curriculum guidance content and structure, prior to wider stakeholder input.

An electronic search of PubMed, MEDLINE, and the ADEE Curriculum Library was undertaken to identify studies relating to undergraduate prosthodontic curricula or education. Titles and abstracts were screened against predefined inclusion and exclusion criteria by a single reviewer, followed by full-text review of eligible articles. Studies were included if they evaluated,



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described previously used, or reported currently implemented undergraduate prosthodontic curricula. Non-English language publications were excluded. Searches of PubMed and MEDLINE using the terms ("Prosthodontic") AND ("Curriculum" OR "Curricula" OR "Education") AND ("Dental Undergraduate*" OR "pre-doctoral" OR "Dental Student*")* yielded 620 records, of which 15 met the inclusion criteria. An additional search of the ADEE Curriculum Library using the term "Prosthodontics" identified two relevant records. The 17 included articles were subsequently used to inform the development of curriculum Learning outcomes.

The original draft curriculum guidance produced by the group consisted of 98 LOs and 16 competencies listed within 4 capability domains:

1. Knowledge of the scientific and evidence-base,
2. general prosthodontics,
3. indirect restorations and,
4. removable prosthodontics.

In line with ADEE recommendations, and in order to better support educators when integrating the LOs into their local curricula, the LOs were categorised into 3 groups—'Fundamental', 'Supporting Clinical' and 'Clinical' (Table 1).

- *Fundamental* (assessable through discussion or written assessment)
- *Supporting Clinical* (directly observable within a clinical or skills environment, or through case-based discussion or written assessment)
- *Clinical* (directly observable within a clinical or skills environment)

**TABLE 1** | Categories of learning outcomes to facilitate implementation in assessment strategy and selection of appropriate teaching environment.

| | |
|---|---|
| Fundamental LO | Assessable through discussion or written assessment |
| Supporting Clinical LO | Directly observable within clinical or skills environment, or through case-based discussion, or written assessment |
| Clinical LO | Directly observable within a clinical or skills environment |

The first capability domain, Knowledge of the Scientific and Evidence-base, encompasses the scientific knowledge base relevant to indirect restorations and prosthodontics. This consisted of 16 LOs: 11 *Fundamental* and 5 *Supporting Clinical* LOs. As this domain covers didactic teaching only, it does not contain any clinical competencies.

The second capability domain, General Prosthodontics, covers diagnosis, risk assessment, classifications and screening tools, diagnosis and treatment planning related to indirect restoration and prosthodontic treatment. This domain includes the importance of preventative management as recommended by the GED. A broad range of LOs are covered including anatomy, biomaterials science, occlusion, special investigations, laboratory considerations, dental hard tissue disease, patient assessment, tooth assessment, the wider dental team and types of indirect restorations and dental prostheses. This domain included 27 LOs: 14 *Fundamental*, 2 *Supporting Clinical* and 11 *Clinical* LOs, as well as 7 clinical competencies.

The third capability domain, Indirect Restorations, and fourth capability domain, Removable Prosthodontics, outline the LOs related to the stages of planning and delivery of indirect and removable dental prostheses respectively. The Indirect Restorations domain contained 27 LOs: 14 *Fundamental*, 5 *Supporting Clinical* and 8 *Clinical* LOs, as well as 5 clinical competencies. The Removable Prosthodontics domain consisted of 28 LOs: 10 *Fundamental*, 7 *Supporting Clinical* and 11 *Clinical* LOs, as well as 4 clinical competencies.

## 2.2 | Modified-Delphi Process

A modified-Delphi process was followed with the aim of quantifying the level of agreement for the clarity, importance and difficulty of teaching for each LO. The survey was planned to be held over three rounds, with each round consisting of the completion of an online-questionnaire followed by an in-person meeting of interested parties [25]. The timeline of the curriculum development process is shown in Figure 1. The modifications to the classical Delphi process included:

- Combined use of a self-administered questionnaire and a physical meeting of participants to discuss the results within each round (as opposed to a survey only).
- Development of an open access, multi-stakeholder online survey to gather wider responses that would inform discussion within each round.
- Encouraging new responders within each round (as opposed to responses from the same panel between rounds).




**FIGURE 1** | Timeline outlining the modified-Delphi process.



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- Aim to establish a *level of agreement* for the clarity, importance and difficulty to teach for each LO (as opposed to repetition of rounds until a specified dichotomous consensus is met) [26].

#### 2.2.1 | The Questionnaire Survey

The survey was designed to establish a *level of agreement* for each LO as well as assess opinions on structure and content. It consisted of 98 questions (one per LO) and 4 free text comment sections (specifically relating to each capability domain, its LOs/competencies and its construct). The survey evaluated the clarity (clear/less clear), importance (essential/important/aspirational) and difficulty (easier/more difficult to teach) of each LO [23, 24]. Free text comment sections were provided to collect qualitative feedback for the LOs, competencies and overall curriculum design.

Whilst the survey was shared with the educational community, key organisations were contacted directly via email with an invitation to complete the questionnaire. The email invitation was sent to all BSSPD and ADEE members, as well as organisations, societies and associations identified by the BSSPD working group as being stakeholders with an interest in prosthodontics and education.

Responses to the questionnaire were reviewed by the BSSPD working group following each survey round. Data and comments were prepared for discussion within the in-person meetings.

#### 2.2.2 | In-Person Meetings

In-person meetings were held at the following meetings:

- 2024 BSSPD annual conference (18/04/24 Cardiff, Wales)
- 2025 BSSPD annual conference (04/04/2025 London, England)
- 2025 ADEE annual meeting (21/08/25 Dublin, Ireland).

Members of the BSSPD and ADEE were invited to attend in-person meetings prior to each conference. Members with an interest in dental education, prosthodontics or both attended. Survey results and comments were presented during the in-person meetings. The most recent percent agreements for clarity, importance and difficulty to teach were presented. Further comments were made and recorded regarding LO/competency/curriculum design. The following was completed on each occasion:

- Borderline agreements were reviewed and an outcome for LO categorisation was reached after open discussion.
- LOs that were 'less clear' were reviewed, and suggestions for improvement made.
- LOs that were 'important', 'aspirational' or 'more difficult' were reviewed and comments made for further clarity
- All comments were reviewed and amendments to the curriculum guidance were proposed.

## 3 | Results

### 3.1 | Response Rate

The survey response rates for each round are displayed in Table 2. In the first round, there were 9 respondents (7 individuals and 2 societies/organisations). In the second round there were an additional 18 respondents (13 individuals, 2 institutions, 2 societies/organisations, and 1 regulator). There were no survey responses in round 3. In total there were 27 respondents from 11 different countries.

### 3.2 | Survey Outcome

The outcomes of each modified-Delphi round including the survey period and in-person meetings are displayed in Table 3. The survey collected a total of 69 free text comments and in-person meetings generated 73 comments. Over the three different in-person meetings there were in total 60 attendees. The outcomes for agreements regarding LO clarity, importance and difficulty to teach within each round are detailed in Table 3. The overall agreement thresholds met for LO clarity, importance and difficulty to teach are listed in Table 4. Clarity (clear/not clear) achieved the highest level of agreement, followed by importance (essential/important/aspirational) and lastly difficulty to teach (easier/more difficult to teach).

Within the survey period and during in-person meetings, multiple comments identified duplications of LOs within and between capability domains. Following the survey period, all LOs underwent final review and 8 duplications were removed. The final curriculum document contains 90 LOs. The final results of the multi-stakeholder process are presented in Table 5. 100% ($n = 98$) of LOs were considered clear. The majority of LOs (95%, $n = 93$) were considered essential, 5% ($n = 5$) important and none were deemed aspirational. Of the LOs considered important, three were in Capability Domain 1, Knowledge of the scientific and evidence-base, and two in Capability Domain 2, General prosthodontics.

The majority of LOs (73%, $n = 72$) were considered easier to teach and 27% ($n = 26$) more difficult to teach. Of those considered more difficult to teach, five were in Capability Domain 1 Knowledge of the scientific and evidence-base, 14 LOs in Capability Domain 2 General prosthodontics, three in Domain 3 Indirect restorations, and four in Capability Domain 4 Removable prosthodontics.

## 4 | Indirect Restorations and Prosthodontics Curriculum Guidelines

The full curriculum guidelines agreed via the modified-Delphi process are listed in the following tables:



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**TABLE 2** | Respondents for the three survey rounds.

| Round | No. | Response | Country | Response type |
|---|---|---|---|---|
| 1 | 1 | University College London Eastman Dental Institute | England | Individual |
| | 2 | University of Bristol | England | Individual |
| | 3 | Universidade Católica Portuguesa | Portugal | Individual |
| | 4 | Universitat Internacional de Catalunya | Spain | Individual |
| | 5 | University of Aberdeen | Scotland | Individual |
| | 6 | University of Manchester | England | Individual |
| | 7 | Czech Dental Chamber | Czechia | Society/Organisation |
| | 8 | American Dental Education Association | USA | Society/Organisation |
| | 9 | University of the West Indies | Trinidad & Tobago | Individual |
| 2 | 10 | St. George's NHS trust | England | Individual |
| | 11 | Mohammed Bin Rashid University | UAE | Individual |
| | 12 | Mohammed Bin Rashid University | UAE | Individual |
| | 13 | King Abdulaziz University | Saudi Arabia | Institution |
| | 14 | Chulalongkorn University | Thailand | Individual |
| | 15 | University of Liverpool | England | Individual |
| | 16 | University College London Eastman Dental Institute | England | Individual |
| | 17 | Queen Marys University London | England | Individual |
| | 18 | Great Ormond Street | England | Individual |
| | 19 | Kings College London | England | Institution |
| | 20 | Kings College London | England | Individual |
| | 21 | University of Bristol | England | Individual |
| | 22 | University of Manchester | England | Individual |
| | 23 | Individual response | UK | Individual |
| | 24 | Glasgow Dental Hospital and School | Scotland | Individual |
| | 25 | Royal College of Surgeons, Faculty of Dental Surgery, Edinburgh | UK | Society/Organisation |
| | 26 | Royal College of Surgeons, Faculty of Dental Trainers, Edinburgh | UK | Society/Organisation |
| | 27 | General Dental Council | UK | Regulator |

*Note:* Blue: Individual response, Green: Institution response, Purple: Society/Organisation response, Orange: Regulator response.

- Table 6—Capability Domain 1: Knowledge of the scientific and evidence-base.
- Table 7—Capability Domain 2: General prosthodontics.
- Table 8—Capability Domain 3: Indirect restorations.
- Table 9—Capability Domain 4: Removable prosthodontics.

The classification of each LO is defined in the first column as *fundamental* (blue), *supporting clinical* (yellow) and *clinical* (purple) as referenced in Table 1. The LO code and details are provided in columns 2 and 3. The last three columns of each table are colour coded in green, amber or red according to level of agreement for clarity (clear = green, less clear = amber), importance (essential = green, important = amber, aspirational = red) and difficulty (easier to teach = green, more difficult to teach = red) for each LO. The competencies for each domain are listed in the last row of each table.

## 5 | Discussion

### 5.1 | Curriculum Development

Well-designed LOs enable transparency and consistency at an institutional, national and international level with the overall aim to reduce variation in educational divergence. The indirect restorations and prosthodontic curriculum guidelines followed



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**TABLE 3** | Details of the three modified-Delphi rounds including survey responses, in-person meetings and round outcomes.

| Round | Survey period | No. survey respondents | In-person meeting | | Round outcome | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Meeting | Attendees | LO clarity | LO importance | LO difficulty | Comments |
| 1 | 19/02/2024–12/04/2024 | 9 | 2024 BSSPD annual conference (18/04/24 Cardiff, Wales) | 25 | • 94% (92) clear<br>• 6% (6) less clear | • 86% (84) essential<br>• 10% (10) important<br>• 4% (4) aspirational | • 60% (59) easier to teach<br>• 40% (39) more difficult to teach | 20 free text<br>40 in-person meeting |
| 2 | 20/04/2024–31/03/2025 | 18 | 2025 BSSPD annual conference (04/04/2025 London, England) | 7 | 100% (98) clear | • 92% (90) essential<br>• 7% (7) important<br>• 1% (1) aspirational | • 72% (71) easier to teach<br>• 28% (27) more difficult to teach | 49 free text<br>14 in-person meeting |
| 3 | 01/04/2025–21/08/25 | 0 | 2025 ADEE Annual Meeting (21/08/2025 Dublin, Ireland) | 28 | 100% (98) clear | • 95% (93) essential<br>• 5% (5) important | • 73% (72) easier to teach<br>• 27% (26) more difficult to teach | 19 in-person meeting |

**TABLE 4** | Level of agreement achieved via the modified-Delphi process for the outcome categories clarity (clear/not clear), importance (essential/important/aspirational) and difficulty to teach (easier/more difficult to teach) for each LO.

| Agreement threshold | ≥ 70% | 60%–69% | 50%–59% | < 50% |
|---|---|---|---|---|
| Clarity | 97 | 1 | — | — |
| Importance | 62 | 15 | 8 | 13 |
| Difficulty to teach | 32 | 37 | 25 | 4 |

the recommended framework in undergraduate education of clear LOs, organised in domains, within areas of competence, as recommended by the ADEE [2]. LOs were specifically developed to align with the ADEE GED behaviour-based curriculum framework [2]. The classification of LOs as 'Fundamental', 'Supporting Clinical' and 'Clinical' (Table 1) moves away from the traditional listed LO approach with the aim to guide educators around the practical implementation of LOs within teaching and assessment activities in different learning environments. The LOs were categorised based on the environment in which the working group considered they were best taught and/or assessed. The classification offers practical guidance to allow educators to best plan for where the LOs are taught and assessed within the taught curriculum.

Prosthodontic practice is rapidly evolving and undergraduate education must adapt accordingly. The proposed curriculum structure, LOs, and competencies extend beyond traditional procedural-based training to include treatment planning, patient-centred care, interdisciplinary communication, evidence-based practice, digital workflows, and the appropriate use and limitations of artificial intelligence. Collectively, these developments reflect a transition from a procedure-driven curriculum to one that prioritises integrated clinical reasoning, critical thinking, and contemporary professional practice.

## 5.2 | Modified-Delphi Process

A modified-Delphi process was followed in three rounds to encourage structured group communication between the participants involved. This process differed from a traditional Delphi process as initial responses were not constrained to a small panel of participants. Instead, the survey was shared openly in each round, which enabled a wider range of responses. This permitted responses from institutions and organisations as well as individual responders from around the world. Thus, results included a wider range of opinions, and the contents and structure of the curriculum were verified by a number of national and international educational organisations and institutions. This aligns with actions 47, 50, and 59 in the WHO Global Strategy and Action Plan on Oral Health 2023–2030, which state the importance for dental councils and professional associations to collaborate to strengthen effective accreditation for workforce competencies to support education [19].



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**TABLE 5** | Final results of the modified-Delphi process showing percentage outcomes for clarity, importance and difficulty of each LO. Specific LOs which were agreed as 'important' and 'more difficult to teach' are listed within each of the capability domains.

| LO categorisation | % (*n*) | Domain 1: Knowledge of the scientific and evidence-base | Domain 2: General prosthodontics | Domain 3: Indirect restorations | Domain 4: Removable prosthodontics |
|---|---|---|---|---|---|
| *Clarity* | | | | | |
| Clear | 100 (98) | — | — | — | — |
| Not clear | 0 (0) | — | — | — | — |
| *Importance* | | | | | |
| Essential | 95 (93) | — | — | — | |
| Important | 5 (5) | K002, K008, K009 | P003, P004 | — | — |
| Aspirational | 0 (0) | — | — | — | — |
| *Difficulty* | | | | | |
| Easier to teach | 73 (72) | — | — | — | — |
| More difficult to teach | 27 (26) | K003, K009, K011, K014, K015 | P001, P002, P003, P004, P007, P010, P011, P013, P014, P017, P019, P025, P026, P027 | I018, I020, I021 | R007, R015, R016, R025 |

Three rounds were selected as recommended by Boulkedid et al. 2011 [25]. Some modified-Delphi studies consider the in-person meetings as separate rounds to the survey, which in this study were included in the three survey rounds [25]. Despite the efforts of the working group to promote the survey between the in-person meeting of round 2 and round 3, no further survey responses were achieved. However, as the process to achieve agreement included 7 opportunities for comment and feedback—initial expert group consensus (BSSPD working group), three rounds of online survey (2 in which responses were collected) and in-person meetings (3 of which responses were collected) – the process was still considered robust for analysis of results. The final in-person meeting (round 3) was used to conclude the modified-Delphi process as after 18 months of active data collection—100% (98) of LOs were agreed to be clear, 95% (93) essential and 73% (72) easier to teach (Table 3, row 3). After presentation of the results, no individuals in round 3 raised concern about the level of agreement on the clarity/importance/difficulty to teach for LOs, thus no further survey rounds were deemed necessary.

The consensus and closing criteria vary widely among Delphi studies and commonly agreements between 50% and 97% are used [27, 28]. A percentage agreement threshold of 70% was used in this study to categorise LOs for clarity/importance/difficulty to teach [23]. When categorisation had borderline agreement, group discussion was used to finalise the decision which is recommended when reaching agreement is difficult [25]. In comparison to similar curricula guidance, this is the first time the clarity, importance and difficulty of each LO has been assessed. Furthermore, the methodology of using a modified-Delphi process to develop curriculum guidance (in comparison to a closed working group) is unique and enabled a wider range of responses, including that of societies, institutions and organisations. This appears to be a more contemporary way to gain consensus for curriculum guidance, as a similar method has recently been proposed by a working group developing undergraduate curricula for paediatric caries management [29].

The modified-Delphi process enabled a wide range of responses; however, in-person meetings were limited to conference attendance in which the meetings were held. This resulted in a difference in numbers of attendees for the in-person meetings and a variation in educational experience between the attendees. This removed the ability of respondents to closely follow changes and develop a deeper knowledge of the agreement process throughout each round. To counteract this, the BSSPD working group remained consistent throughout, and increased efforts were made at each in-person consultation to communicate the results and proposed changes.

### 5.3 | Implementation

Designing evidence-based curriculum guidance is one challenge; however, enabling implementation of such curricula for educators is another. To provide direction for the practical implementation of this curriculum guidance, each LO is classified as 'Fundamental', 'Supporting Clinical' and 'Clinical'. This classification aims to broadly define assessment styles most appropriate for each LO, as well as possible learning environments (Table 1). 'Fundamental' LOs (assessable through discussion or written assessment) are suited to the didactic teaching environments such as lectures, seminars and online learning. 'Supporting Clinical' LOs (directly observable within clinical or skills environment, or through case-based discussion, or written assessment) are suited to didactic, pre-clinical and clinical teaching environments. 'Clinical' LOs (directly observable within a clinical or skills environment) are appropriate for the clinical teaching environment.



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**TABLE 6** | Capability Domain 1: Knowledge of the scientific and evidence-base.

| | Code | Learning outcome | Clarity | | Importance | | | Difficulty | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clear | Less clear | Essential | Important | Aspirational | Easier to teach | More difficult |
| Fundamental LOs | K001 | The aetiology, pathology, diagnosis and management of oral diseases and disorders including (but not exclusively): i) caries, ii) tooth wear, iii) gingival, periodontal and peri-implant diseases, iv) apical periodontitis, v) temporomandibular joint dysfunction and occlusal disharmony, vi) mucosal conditions and salivary pathology vii) developmental disorders of the hard tissues viii) oral cancer | | | | | | [a] | |
| | K002 | Age-related changes in oral tissues and their associated functions | | | [b] | | | | |
| | K003 | Social and behavioural sciences, including factors that facilitate the delivery of oral health care | | | [b] | | | [a] | |
| | K004 | The hazards of ionising radiation and the regulations relating to its use in Dentistry | | | | | | | |
| | K005 | Dental materials used in the clinical and laboratory stages for indirect restorations and prosthodontics - their properties, risks, benefits and limitations - including environmental/political/biocompatibility issues relevant to their use | | | | | | [a] | |
| | K006 | The survival and success rate associated with various types of indirect and removable prosthodontic interventions, including dental implants and their associated restorations | | | [a] | | | [a] | |
| | K007 | The potential limitations, risks and benefits of dental technological procedures | | | [b] | | | [a] | |
| | K008 | The epidemiology (including incidence and prevalence) of missing teeth, and the subsequent need for restoration with indirect restorations and prosthodontics | | | [a] | | | [a] | |
| | K009 | Various principles of occlusal design in dentate, partially dentate and edentulous patients | [a] | | [b] | | | | |
| | K010 | The concept of the 'Shortened Dental Arch' | | | [a] | | | | |
| Supporting clinical LOs | K011 | Communication and language development, specifically with diverse populations | | | [b] | | | | |
| | K012 | Sterilisation, disinfection and decontamination, and the core principles of infection prevention and control | | | | | | | |
| | K013 | Clinical, technological and other diagnostic procedures and tests | | | [a] | | | [a] | |
| | K014 | The impact of changes in oral health, and dental interventions, on the quality of life | | | [b] | | | [a] | |
| | K015 | Behaviour change to influence oral and general health in the prosthodontic patient cohort accounting for their specific vulnerabilities | | | [b] | | | | |

*Note:* Coloured box only: ≥ 70% agreement in survey results.
[a]50%–69% agreement in survey results.
[b]< 50% agreement in survey results.

Establishing the importance for each LO enables educators to prioritise the LO delivery within their local curricula, considering differences in institutional circumstances, student and patient population circumstances. It was expected that the consensus view on these aspects would help educators to use the document to maximum effect when deriving local curricula. The perceived difficulty of teaching for each LO was established to develop a deeper understanding of the challenges in the delivery of prosthodontic education, with the aim to identify areas where educators need more instruction or support to deliver a modern undergraduate prosthodontic curriculum. LOs perceived to be more difficult to teach fell within five broad themes: communication and professionalism, occlusion, advanced dental hard tissue diseases (restorability assessment, tooth wear and developmental disorders), dental implantology and aspects of treatment planning. These areas have been traditionally considered advanced topics which may explain the categorisation as "more difficult to teach". It also reflects the increased educational complexity associated with developing competencies in treatment planning, communication, clinical judgement, and decision-making, which extend beyond the acquisition of technical and procedural skills alone. However,



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**TABLE 7** | Capability Domain 2: General prosthodontics.

| | Code | Learning outcome | Clarity | | Importance | | | Difficulty | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clear | Less clear | Essential | Important | Aspirational | Easier to teach | More difficult |
| | P001 | Discuss how various presentations of caries will impact on the treatment planning and prognosis of indirect restorations and dental prostheses | | | | | | [a] | |
| | P002 | Discuss the general principles associated with planning and restoring moderate to advanced tooth wear | | | [a] | | | [a] | |
| | P003 | Discuss the indications and contraindications for prescribing relative axial tooth movements when managing the worn dentition | | | [b] | | | | |
| | P004 | Explain the benefits of accurate study models and diagnostic methods in the planning process when managing tooth wear, indirect restorations, and removable prostheses | | | | | | | |
| | P005 | Explain the problems associated with inaccurate or distorted impressions, how these most frequently occur, and how to best prevent this from happening | | | | | | | |
| | P006 | Describe the anatomical factors determining the movements of the mandible including the temporomandibular joint complex, muscles of mastication and occlusion | | | | | | [a] | |
| | P007 | Describe the concept of a mutually protective occlusion, and the features of occlusal schemes that demonstrate canine guidance, and group function | | | | | | [a] | |
| | P008 | Define the terms Intercuspal position (syn. centric occlusion), Retruded arc of closure (syn. centric relation), Retruded contact point, Occlusal Vertical Dimension, and Freeway space | | | | | | [a] | |
| | P009 | Describe general assessment for implant provision (relating to the hard and soft tissues), and discuss various risk factors for each | | | [b] | | | [a] | |
| | P010 | Describe the ways in which genetic and developmental disorders of teeth can present, and the potential impact on oral health and the delivery of care | | | [a] | | | [a] | |
| | P011 | Describe prosthodontic technological procedures, and explain how they can be used to create or facilitate the construction of indirect restorations and removable prostheses | | | | | | | |
| | P012 | Describe the ways in which AI can be utilised for prosthodontic planning, including the benefits and limitations of using such technologies | | | | | | [a] | |
| | P013 | Describe the biomechanical consequences of poorly-designed fixed and removable prostheses | | | [a] | | | [a] | |
| | P014 | Explain how dental articulators and ear/facebows are classified and used, and in which cases each should be employed | | | [a] | | | [a] | |
| Supporting | P015 | Describe the mechanical properties of dental materials commonly used for indirect restorations and prosthodontics and explain how these materials are indicated in different clinical scenarios | | | | | | [a] | |
| Supporting | P016 | Discuss the potential anatomical, aesthetic, functional and psychological effects of tooth loss | | | | | | [a] | |
| Clinical LOs | P017 | Correctly decide when to refer patients with complex treatment needs | | | | | | [a] | |
| Clinical LOs | P018 | Explain to patients the ways in which teeth can be replaced (including implants) and discuss the risks and benefits of each approach, including estimates of longevity or success | | | [a] | | | [a] | |
| Clinical LOs | P019 | Apply the knowledge of indirect and removable restoration types, their risks and benefits in any given scenario, to formulate an appropriate patient-centric treatment plan | | | | | | [a] | |
| Clinical LOs | P020 | Acquire the necessary information in order to decide whether teeth are suitable to be considered as abutments for fixed and removable dental prostheses | | | | | | | |
| Clinical LOs | P021 | Acquire an accurate and relevant patient history particularly in relation to problems associated with the hard tissues, or existing prostheses - including social and pain histories, preventive regimes, dietary habits and relevant aspects of the medical history | | | | | | | |
| Clinical LOs | P022 | Execute and record an accurate clinical examination with particular focus on restorative elements – such as hard and soft tissue charting, screening for periodontal disease and tooth wear, and a basic occlusal assessment | | | | | | | |
| Clinical LOs | P023 | Appropriately request and report on special tests, or investigations, in relation to the dental hard tissues | | | | | | | |
| | P024 | Formulate appropriate diagnoses relating to the restoration or replacement of the teeth | | | | | | | |
| | P025 | Develop a patient-centred treatment plans, by comprehensively discussing all available treatment options, including their expected risks, benefits and longevity | | | | | | | |
| | P026 | Maintain open and effective channels of communication with the technical team when prescribing, designing and constructing indirect restorations and removable prostheses | | | | | | [a] | |
| | P027 | Correctly screen for tooth wear and discuss how early, moderate, and severe presentations are typically managed | | | | | | [a] | |

Competencies:

- Obtaining an accurate and comprehensive patient assessment
- Deriving a patient-centric treatment plan
- Carrying out a basic occlusal assessment
- Deriving a patient-centric risk assessment (across various domains)
- Obtaining valid patient consent
- Obtaining basic records (models, photos)
- Making an assessment of tooth restorability

*Note:* Coloured box only: ≥ 70% agreement in survey results.
[a] 50%–69% agreement in survey results.
[b] < 50% agreement in survey results.



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**TABLE 8** | Capability Domain 3: Indirect restorations.

| | Code | Learning outcome | Clarity | | Importance | | | Difficulty | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clear | Less clear | Essential | Important | Aspirational | Easier to teach | More difficult |
| Fundamental LOs | I001 | Explain the basic technical procedures associated with fabrication of indirect restorations | | | [b] | | | [a] | |
| | I002 | Describe the ways in which missing tooth tissue can be managed indirectly, including with crowns, inlays, onlays, veneers and posts and cores. | | | | | | | |
| | I003 | Describe the ways in which missing teeth (and their associated functions) can be managed with bridges or dental implants | | | | | | | |
| | I004 | Explain the concept of a ferrule, and where on a tooth this feature is most important for any given type of indirect restoration | | | | | | [a] | |
| | I005 | Explain the principles of tooth preparation and ideal occlusal design, relating to indirect restorations | | | | | | [a] | |
| | I006 | Correctly describe the types of preparation or adjustment required for indirect restorations manufactured in different dental materials | | | | | | [a] | |
| | I007 | Define a conventional and adhesive luting agents and describe their different mechanisms of action in retaining restorations, across a range of clinical scenarios | | | | | | [a] | |
| | I008 | Describe the various types of intra-radicular post (direct, indirect, surface features, shape, method of cementation) and the risks, benefits and likely impact of each in any given case | | | [a] | | | [a] | |
| | I009 | Describe the ways in which the gingival tissues can be managed and manipulated in order to obtain accurate records for the construction of indirect restorations | | | | | | | |
| | I010 | Discuss the intended functions of a well-constructed provisional restoration and the potential advantages and disadvantages of the method of fabrication | | | | | | [a] | |
| | I011 | Discuss the various ways in which diagnostic work-ups can be used to aid in the planning and placement of indirect restorations | | | [a] | | | [a] | |
| | I012 | Discuss the range of pontic designs and how these effect aesthetics, mechanical properties and clensibility | | | | | | | |
| Supporting Clinical LOs | I013 | Justify choices of lute/cement when fitting indirect restorations | | | | | | [a] | |
| | I014 | Justify choices regarding which teeth could act as abutment teeth when designing fixed prostheses | | | | | | [a] | |
| | I015 | Understand how to dismantle different interim and definitive indirect restorations | | | [a] | | | [a] | |
| | I016 | Discuss the indications and contraindications for indirect restorations, including crowns, onlays, inlays, bridges, posts, cores, and veneers | | | | | | | |
| Clinical LOs | I017 | Correctly assess the level of restorability of broken-down teeth and incorporate this information appropriately into the treatment planning process | | | | | | [a] | |
| | I018 | Consider the interface between indirect restorations, removable, and direct prosthetics when treatment planning | | | [a] | | | [a] | |
| | I019 | Effectively prepare hard tissues to receive indirect restorations of varying complexity, including crowns, veneers, and inlays/onlays and bridge retainers | | | | | | | |
| | I020 | Effectively prepare and place an intra-radicular post and an associated core material | | | | | | | |
| | I021 | Obtain accurate working impressions and adjuncts (registration, opposing impression) for the construction of indirect restorations | | | | | | | |
| | I022 | Effectively construct and place chair-side provisional restorations for indirect restorations | | | | | | | |
| | I023 | Provide accurate records for, and effectively prescribe diagnostic work-ups from the laboratory | | | [a] | | | [a] | |

Competencies

- Single crown workflow (assessment, preparation, impression, provisional, fit)
- Resin-retained bridge workflow (assessment, preparation if required, impression, provisional, fit)
- Conventional bridge workflow (assessment, preparation, impression, provisional, fit)
- Inlay/onlay/veneer workflow (assessment, preparation, impression, provisional, fit)
- Indirect restoration of the endodontically-treated tooth workflow (assessment, preparation, impression, provisional, fit)

Coloured box only: ≥70% agreement in survey results

[a] 50%–69% agreement in survey results.
[b] < 50% agreement in survey results.



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**TABLE 9** | Capability domain 4: removable prosthodontics.

| | Code | Learning outcome | Clarity | | Importance | | | Difficulty | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Clear | Less clear | Essential | Important | Aspirational | Easier to teach | More difficult |
| Fundamental LOs | R001 | Explain the basic laboratory procedures associated with fabrication of removable prostheses | | | | | | | |
| | R002 | Describe the ways in which missing teeth and soft tissues (and their associated functions) can be managed with removable dental prostheses | | | | | | | |
| | R003 | Discuss the physical and psychological benefits of retaining healthy roots as overdenture abutments | | | [a] | | | [a] | |
| | R004 | Rationalise approaches to tooth preparation or adjustment required for the provision of removable prostheses | | | [a] | | | [a] | |
| | R005 | Describe the benefits and limitations of using definitive and temporary registration bases | | | [a] | | | [a] | |
| | R006 | Discuss the significance of utilising hard and soft tissue support when designing partial dentures | | | | | | | |
| | R007 | Correctly explain the clinical and technical processes for constructing complete, partial, immediate and copy dentures | | | [a] | | | [a] | |
| | R008 | Undertake clinical procedures necessary for repair, relining and addition of teeth to partial and complete dentures | | | | | | [a] | |
| Supp | R009 | Rationalise approaches to material use, for hard and soft tissue support, when designing partial dentures | | | | | | | |
| | R010 | Justify choices regarding which teeth are able, or unable, to support prosthetic loading when designing a tooth and mucosa-borne prostheses | | | [a] | | | [a] | |
| | R011 | Follow a systematic approach to partial denture design and rationalise choices for each specific denture component in any given case | | | | | | [a] | |
| | R012 | Accurately prescribe a partial denture design to the laboratory | | | | | | [a] | |
| | R013 | Effectively troubleshoot problems with the fit or accuracy of denture bases and frameworks | | | | | | [a] | |
| | R014 | Correctly identify, and effectively troubleshoot problems presenting at the try-in stage of complete and partial prostheses | | | | | | | |
| | R015 | Discuss the ways in which patients might access or be suitable for the provision of implant-supported prostheses | | | [b] | | | [a] | |
| Clinical LOs | R016 | Acquire and quality assure accurate primary impressions of edentulous or partially dentate arches | | | | | | [a] | |
| | R017 | Correctly prescribe and adjust special trays for edentulous and partially dentate arches and acquire, and quality assure, an accurate functional impression | | | | | | [a] | |
| | R018 | Explain the importance of, and acquire, an accurate preliminary occlusal registration prior to designing removable prostheses | | | | | | [a] | |
| | R019 | Outline and appropriately record the main biometric markers that determine tooth position, when constructing removable prostheses | | | | | | [a] | |
| | R020 | Correctly assess the fit of a cobalt-chrome (or resin pattern) denture framework | | | | | | [a] | |
| | R021 | Accurately and passively record the maxillomandibular relationship of the jaws using partial or complete registration blocks | | | | | | [a] | |
| | R022 | Accurately assess the diagnostic work-ups of complete and partial dentures | | | | | | [a] | |
| | R023 | Discuss prognosis and manage patient expectations throughout the whole process of complete and partial denture planning and construction | | | | | | [a] | |
| | R024 | Effectively deliver the fit of complete and partial dentures, also ensuring that patients understand the process of insertion and removal, denture care, and how to manage problems that might present in the early stages of use | | | | | | | |
| | R025 | Discuss with patients the concept of implant-supported removable prostheses as a method of improving retention and stability | | | [a] | | | [a] | |

Competencies

- Complete denture workflow (assessment, primary impressions, major impressions, registration, try-in, fit, review)
- Partial denture workflow (chrome) (assessment, preliminary registration & design, major impressions, framework try-in, registration, try-in, fit, review)
- Partial denture workflow (acrylic) (assessment, preliminary registration & design, major impressions, registration, try-in, fit, review)
- Immediate denture workflow

*Note:* Coloured box only: ≥ 70% agreement in survey results.
[a]50%–69% agreement in survey results.
[b]< 50% agreement in survey results.



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further details as to why these specific LOs were "more difficult to teach" were not directly assessed in this survey, which is a limitation of the current study. Identifying the challenges associated with teaching these LOs would be beneficial to aid the implementation of such curriculum guidance. Therefore, further research exploring exactly why these specific LOs are perceived as "more difficult to teach" would help to identify underlying challenges and inform strategies to support implementation. The process of deconstructing more complex tasks and teaching essential skills early, and reinforcing longitudinally, is described previously by Field et al. 2022 [30].

The curriculum guidance is tabulated to allow educators to review their current education, map it to the LOs and competencies and identify strengths and weaknesses. The information provided in each LO is intended to provide enough detail for educators to deliver a comprehensive and evidence-based curriculum, whilst allowing enough breadth for local interpretation based on local population, student and staff requirements. The 'importance' of the LO can be used to allow educators to target resources towards 'essential' LOs.

Despite aiming to develop curriculum guidance that could be effectively and straightforwardly implemented, 98 LOs was sometimes considered excessive by some participants, and this was noted during the survey and in-person meetings. Efforts were made to reduce the number of LOs, however as the majority were agreed as essential following the survey rounds, reductions were limited to duplications only. The final curriculum guidelines contain 90 LOs and 16 competencies. When comparing this number of LOs to similar curricula in the restorative field, this figure sits towards the middle-high range (Figure 2). Including too many LOs can risk the approach of focusing on check box-style task completion rather than holistic competence. However, too few LOs can lead to a lack of specificity for effective assessment or skills development. Prosthodontics is a broad subject area, combining materials science, dental technology, epidemiology and clinical skills for fixed and removable prosthesis delivery. When drafting the curriculum guidelines, the working group aimed to develop LOs based on the fundamental prosthodontic knowledge and skills a 'safe beginner' would require. Due to the breadth of the prosthodontic field, this resulted in a high number of LOs. Part of the survey aimed to establish the 'importance' of each outcome, and unexpectedly the majority LOs were considered essential. It is possible that targeting responders with an interest or expertise in prosthodontics influenced this high level, strong agreement. It is acknowledged that the high number of 'essential' LOs creates a potential conflict between comprehensiveness and curriculum overload. Given the substantial overlap between topics within prosthodontic teaching, implementation could involve combining related LOs into an adaptable framework that may be integrated, grouped and developed longitudinally according to local curricula. Such an approach reflects the Graduating European Dentist framework's emphasis on flexibility and adaptation to local educational contexts [31]. Nevertheless, a high number of LOs could compromise the ease of curriculum implementation, and therefore continued reflection and revision of the curriculum guidance is advised.

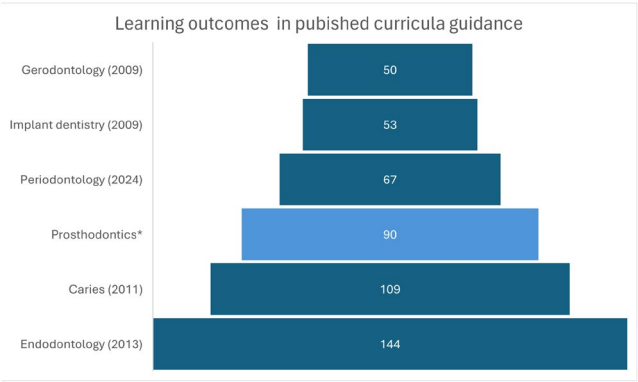



**FIGURE 2** | Number of learning outcomes (per curricula guidance document) within recent published curricula within the restorative field (*relates to learning outcomes within this curriculum guidance).

### 5.4 | Future Work

It is recommended that the LOs considered "more difficult to teach" are explored by a group of expert educators. This would enable the development of expert-led resources to assist educators in strategies for teaching and assessing these more challenging LOs. Furthermore, the need for further work to develop more defined methods of teaching and assessment is recommended. This paper will be submitted to the ADEE GED taskforce for inclusion within the Domain III curriculum library. Future revision of this curriculum guidance is recommended within 10 years of publication to account for advances in prosthodontic teaching, digital technology and educational developments.

## 6 | Conclusions

This prosthodontic curriculum guidance offers a contemporary, consensus-informed framework developed with broad international stakeholder input that can be adapted by individual dental schools and countries when developing or revising prosthodontic curricula.


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#### Conflicts of Interest

The authors declare no conflicts of interest.

#### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.



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