Orthodontic undergraduate education: assessment in a modern curriculum

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This paper describes the problems of assessment for students on an undergraduate orthodontic course which is using problem-based learning to encourage active self-learning, deep learning and give students the skills to become effective lifelong learners in the future. Traditional assessment does little to encourage a range of behaviours and skills which are encouraged through problem-based learning but which must be rewarded, in the minds of the students, by the chosen method of assessment. This is because learner behaviour is driven by assessment. Details of the range of assessment methods available and those chosen on the orthodontic undergraduate course at the University of Manchester Dental School are reported and discussed.

Key words: undergraduate; orthodontics; dental education; assessment; problem-based learning.

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This paper has been written to highlight the problems of assessment for dental students on learning programmes which are increasingly moving towards a problem-based, self-directed style of teaching. Problem-based learning (PBL) is an increasingly popular teaching technique in professional education such as medicine and dentistry. As the name suggests PBL is an educational approach where the learning process focuses on the need to understand a problem. On a PBL programme, students must take an active role in their own learning whilst the tutor has a role as a facilitator (1). PBL is centred on a specific problem or scenario that provides the focus for the setting of learning objectives. Concern has been raised over the breadth of content covered by this approach as PBL is directed by the students themselves. However, students’ active learning promotes ownership of learning; thinking and social interaction and collaboration are needed to solve the problems. It appears that if the student is involved in the search for knowledge with a purpose, then that knowledge is more readily recalled when faced with the ‘real life’ situation. Also, it is hoped that the process of searching for information and the skills learnt participating in a group would equip the student to become a better lifelong learner.

The published literature suggests that graduates from programmes where PBL is used appear to have a comparable or slightly inferior knowledge base but are identifiable from their peers on didactic programmes as having a less jaundiced view of the undergraduate experience (2). Traditional teaching has the advantage of better coverage of curriculum content (3) but although PBL may reduce initial levels of memorization, it improves long-term retention (4). However,
more recent work seems to suggest that the anxieties about content knowledge using PBL may have been overstated (1). Traditional assessment methods favour traditional teaching methods. When standardized tests are used, which favour neither method of teaching, this content knowledge effect is reduced (5).

Assessment
Assessment may be ‘formative’ within the teaching process, feeding back to students to guide their progress. Formative assessment is aimed at assisting the learning process. Alternatively, assessment may be ‘summative’ making formal decisions about progress and the level of achievement. It has been suggested that too much assessment in British higher education is focused on the summative (6).

Assessment is an integral component of the teaching and learning system and may be used explicitly to guide students in their study. Importantly, student perceptions of what is rewarded and what is ignored by assessment procedures will have a substantial impact on their learning behaviour and upon the outcome of a course (7). Although PBL is both learner centred and student led, learner behaviour will still, in part, be driven by assessment. It is, therefore, essential for assessment not only to test knowledge but also test other skills developed through PBL. This is best achieved by using a range of assessment methods (8).

Students’ thoughts and actions are profoundly affected by the educational context or environment in which they learn. An important part of good teaching is to try to understand these contextual effects and to adapt assessment and teaching strategies accordingly (9). To be effective, assessment needs to reflect the programme content and the assessment method needs to be valid, reliable and fair (10). It can be argued that the greater the diversity in the methods of assessment the fairer the assessment is to students (11). It thus seems clear that if a PBL course is followed by traditional assessment, this will influence learner behaviour and damage students’ understanding of tutor expectations. The use of traditional assessment methods may be due to concern by tutors that students are not acquiring as much knowledge as they would during traditional teaching. This may, in part, explain the reluctance to move to less familiar methods of assessment.

Methods of assessment
We will outline a number of methods of assessment which have been used in dental education, highlight some of their limitations, and then describe the methods currently used to assess students on the orthodontic undergraduate programme at the UMDS.

Essays
Written essay style examinations can be conducted either as a closed book or open book exercise. Traditional closed book essays are a cause for concern as they encourage surface learning. Whereas in open book essays, students’ can waste time wading through too much information and not spend enough time answering the question. There are also anxieties about the validity and reliability of the marking for this form of assessment. Finally, knowledge-based written essays cannot measure many things that are important for dental students such as patient management skills, oral communication skills, practical skills and an ability to apply knowledge in the clinical environment.

Multiple choice questions (MCQs)
The multiple choice questionnaire is a common form of assessment. It is computer compatible which makes marking the assessment very simple and provides a broad coverage of the curriculum. Controversy exists over the positive or negative marks given for responses and the types of learner behaviour this encourages. The questions are difficult to write in an unambiguous way, and in some specialties, it is difficult to develop questions that test higher cognitive thought or questions which only need a simple yes or no response. One approach to solve these problems has been the development of ‘extended matching items’ increasing the sophistication of the MCQ (12).

Short answer questions
Short answer questions have not been shown to test anything other than that which is tested by an MCQ and are less convenient to mark (13). The success of the short answer paper will be determined by the careful selection of questions for content and for length of response. To simply ask for a ‘definition’ would encourage a surface approach to learning and memorization without understanding. Short answer questions are usually marked against a model answer provided by the question setter. This does not guarantee the accuracy or consistency of the marks but would seem to be more valid, reliable and fair than the ‘traditional’ essay format.

Oral examinations: viva-voce
Oral examinations are prone to many errors (7). These include errors relating to the halo effect (judgement of
one attribute influences judgements of others), errors of central tendency and general tendency towards leniency, and errors of contrast (judgements of a candidate influenced by impressions of preceding candidates). One major weakness of a viva-voce is that by necessity it lacks anonymity.

Oral examinations tend to test at a low taxonomic level, factual knowledge rather than problem solving. Scores are related to irrelevant attributes of the candidate such as appearance or confidence and, hence, agreement between examiners is often poor. It is, moreover, difficult to establish in any formal way the validity of an oral examination.

In an attempt to improve oral examinations (14), six elements of oral assessment have been described:

1. Content: knowledge and understanding, applied problem-solving ability, interpersonal competence and personal qualities.
2. Interaction: presentation versus dialogue.
4. Structure: closed structure versus open structure.
6. Orality: purely oral versus orality as secondary.

Supporters of the viva-voce claim that the applied problem-solving ability of the student is tested – the ability to ‘think on one’s feet’. However, it might be argued that such skills would be better tested in a clinical environment and the viva-voce may lack authenticity.

Objective structured clinical examination (OSCE)
The objective structured clinical examination (OSCE) was first described in 1979 (15). This consists of a number of circuits made up of stations through which a candidate must pass. At each station, the candidate must perform a clinical task. The candidate is observed and assessed by an examiner. To further improve objectivity, the examiner is provided with a checklist breaking the task down to its component parts. In recent years, the use of the OSCE in dental and other health-related professions has been growing in popularity, since it allows for some of the claimed advantages of an oral examination whilst ensuring a greater degree of equity for candidates in its administration.

Objective structured long examination record (OSLER)
The OSLER is an alternative to the traditional medical long case (16). Such a change would mean that the candidate would be observed examining the patient and aspects of their performance graded against a ‘checklist’. This is provided to improve the objectivity and consistency of the examiner.

Structured clinical operative test (SCOT)
Recently, the structured clinical operative test (SCOT) was described (17). The SCOT is used in Dundee as a formative assessment. Students perform a specific task that is assessed with reference to an agreed set of objective criteria or ‘checklist’. This form of assessment has been used to encourage students to develop a self-evaluation and it is hoped that it will encourage high clinical standards throughout an individual’s practising lifetime.

Learning portfolios
Portfolios are a purposeful collection of student work that exhibits their efforts, progress and achievement. The portfolio must include student participation in the selection of contents, the criterion for selection being evidence of self-reflection. A portfolio can demonstrate a level of attainment, progression, professional development and achievement (10). The continuing professional development (CPD) diary that all dentists are encouraged to keep and which will eventually be required for recertification could be described as a form of learning portfolio. To be a true portfolio, an index should indicate the contents of the portfolio and be a self-evaluative commentary. The portfolio will be selected by the learner and, therefore, demonstrate reflection on the important aspects of what has been learnt. This may be something to consider for lifelong learning in the future.

Concept maps
Much of the learning that goes on during PBL is more than just a compilation of facts. Written examinations may not, therefore, be an adequate measure of student growth. Asking students to generate concept maps, in which they depict their knowledge through the creation of identified links, may present another option to determine their learning. It is thought that the organization and development of links through learning is important in recall of information when faced with a clinical problem.

Peer assessment
This approach may be a viable option to measure student development. For example, asking students to make a short presentation to their peers. The presentation can be evaluated within a framework worked out in advance within the group. An alternative strategy is to allocate a specific number of marks to a group and the group agrees the distribution of the marks between the members.
Self-assessment

Students are encouraged to identify gaps in their knowledge through a process of reflection. Developing the ability for self-assessment is important for future lifelong learning and continuing professional development. The SCOT is an example of formative assessment through which future self-assessment is encouraged. If dentists undertake lifelong learning, then the formative assessments used in dental school could give them the skills to continue to maintain and enhance their knowledge and skills for the future.

Assessment in practice: the UMDS orthodontic course

To be effective, assessment needs to reflect programme content and be valid, reliable and fair. The nature of assessment must also reflect the course objectives. The course objectives and the structure of the orthodontic course at UMDS have been described previously (18). In a course designed to promote self-directed learning through addressing problems, we utilize approaches to assessment that reflect this. For the reasons described above, tutors may embrace self-directed learning and PBL but retain traditional forms of assessment rather than promote consistent student expectations by implementing a problem-orientated approach, both in learning and assessment. To assess the course, solely using MCQs or short answer questions would indicate that the only important outcome of the PBL process is factual knowledge. As a general principle, evaluation should, when possible, be in the same manner as the students have learnt.

A comprehensive assessment approach has been described for community dentistry in the Netherlands (19). A variety of assessment methods are available: peer assessment, short essay questions, and multiple choice questions. Each method focuses on a specific aspect of the objectives of the programme. This contrasts with the conventional tutor-centred approach traditionally used in the UK.

Assessment in our orthodontic course, therefore, utilizes a number of methods of assessment to ensure that, wherever possible, all the skills learnt are assessed.

Formative assessment

The third year of the undergraduate dental programme at UMDS, which forms the first year of the orthodontic course, is based on directed self-learning (18). Formative assessment takes two forms. At the end of each module, the tutor gives informal feedback to the group members and grades them on an A–E scale (Table 1) for their contribution to the group activity, both in terms of participation and written output. Self-assessment by the group was tried, but the students’ desire to get high grades at this early stage of the course, even in formative assessment, led to unrealistic grades being given. The factual knowledge gain is assessed through a computer-based test using Question Mark’s Perception® software which gives immediate feedback to the student on completion.

The Perception programme is divided into four major components: administration, assessment creation, question delivery and reporting. Administration includes the identification of the student via name and a cross reference with the student’s library card number. The programme will also allow tutor group identification which is useful to audit group/tutor effectiveness. The assessment is managed within the package by a component called the question manager where all the questions are created and stored. The assessment can include all of the questions within the question manager or the session manager can randomly allocate questions. The questions can be written in several styles: MCQ, questionnaire, selection, multiple response, numeric and text match.

The two elements, tutor assessment and knowledge assessment, constitute the formative feedback for the first two modules. For the third and fourth modules of third year, the tutor assessment is repeated, but the knowledge-based formative assessment is replaced with a summative assessment.

The fourth year of the orthodontic course is integrated with paediatric dentistry and dental public health and taught through PBL and, again, tutor assessment is the main source of formative assessment. It is important that the tutor acts as a facilitator in a PBL group and does not dominate the group. To facilitate exploration and learning, the tutor acts as a guide to learning rather than the font of all wisdom. One of the tutor’s most important roles is to assess how successfully individuals interact within the group.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Meritorious</td>
</tr>
<tr>
<td>B</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>C</td>
<td>Barely satisfactory</td>
</tr>
<tr>
<td>D</td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>E</td>
<td>Poor performance</td>
</tr>
</tbody>
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Orthodontic undergraduate education
and assess an individual’s cognitive development. To aid in making formative assessment, more objective criteria were developed in two areas to assess individuals’ contribution to the group, and these grades are given in association with an overall grade given to the group for its performance in each PBL module (Table 2).

**Summative assessment**

Traditionally, assessment for dental students is a criterion reference assessment, where particular skills or behaviour are each specified against a criterion that must be reached (6). Criterion referenced assessment has been described as ‘an inadequate judgement by a biased and variable judge of the extent to which a student has attained an ill-defined level of mastery of an unknown proportion of an indefinite material’ (20).

Summative assessment is performed at various stages of the 2-year orthodontic course using a variety of assessment methods. At the end of third year, an OSCE is used to assess both knowledge and clinical skills learnt through the directed self-learning course. Stations include practical clinical skills in orthodontic diagnosis as well as knowledge-based and clinical problem solving exercises.

The fourth year course is summatively assessed as part of the professional examination at the end of the year. The assessment combines written and oral examinations. The written examination includes a short answer question section to examine knowledge, and a case scenario-based section where the students have to draw on their experience of PBL to identify the key issues raised and integrate knowledge into an explanation of the scenario and discuss management options. The oral examination is again centred on a case scenario. The student is allowed 30 min to consider the case, and again identify the key issues and management strategies. The 20-min oral examination that follows is a discussion of the clinical scenario rather than a question and answer session and, as such, is aimed at assessing the students ability to cope in the clinical environment and is not primarily intended as a test of knowledge.

**Discussion**

By encouraging the development of self-learning skills and deep learning, PBL aims to equip the dentists of the future with knowledge and understanding relevant for today, together with the skills to tackle the questions of tomorrow (18). It is essential that the methods of assessment used consolidate these principles as assessment will, at least in part, drive the learning experience.

Perhaps, the most controversial method of assessment we choose to employ is the viva-voce assessment. In order to encourage deep learning, students should be encouraged to relate ideas to their previous knowledge and experience (21). Students should look for patterns and underlying principles checking the evidence and relating it to conclusions. They should use logical arguments to support their assertions and it is hoped the viva-voce, as described here, is a suit-

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**TABLE 2. Objective criteria for PBL assessment**

<table>
<thead>
<tr>
<th>Group grade</th>
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<tbody>
<tr>
<td>A</td>
<td>All learning objectives covered in depth with suitable presentations and handouts</td>
</tr>
<tr>
<td>B</td>
<td>All learning objectives covered, but some only superficially</td>
</tr>
<tr>
<td>C</td>
<td>One main learning objective not covered</td>
</tr>
<tr>
<td>D</td>
<td>Two main learning objectives not covered</td>
</tr>
<tr>
<td>E</td>
<td>More than two main learning objectives not covered</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual professional attitude</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Prompt attendance at all seminars, active group member</td>
</tr>
<tr>
<td>B</td>
<td>Prompt attendance at all seminars, passive group member</td>
</tr>
<tr>
<td>C</td>
<td>Late/absent from one or more session with authorized reason for absence (this does not include timetabled absences)</td>
</tr>
<tr>
<td>D</td>
<td>Late/absent from one session without authorized reason for absence</td>
</tr>
<tr>
<td>E</td>
<td>Late/absent from more than one session without authorized reason for absence</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Individual professional knowledge</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Application of prior knowledge and use of resources to produce in depth handout and presentation on one or more learning objective</td>
</tr>
<tr>
<td>B</td>
<td>Application of prior knowledge and use of resources to produce handout and presentation on one or more learning objective</td>
</tr>
<tr>
<td>C</td>
<td>Application of prior knowledge and use of resources to produce superficial/inadequate handout and presentation on one or more learning objective</td>
</tr>
<tr>
<td>D</td>
<td>Failure to produce either handout or presentation</td>
</tr>
<tr>
<td>E</td>
<td>Failure to produce both handout and presentation</td>
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able forum to test these skills. In addition to this, interpersonal competence is tested in a viva-voce assessment and the personal skills required for a professional approach (22). These skills exhibited in relation to a clinical scenario are the focus of the oral examination. There are a number of personal attributes that oral examinations have claimed to measure (23), including personality, alertness, reactions to stress, appearance, confidence and self-awareness. This part of the assessment is a test of these characteristics in addition to orthodontic knowledge and competence. One of the advantages of the oral examination has been described as the interaction between examiner and candidate (24). The candidates’ fate is in their own hands. If they make a competent assessment and develop appropriate management strategies, the viva-voce is a very friendly exchange. However, if the candidate makes errors, the examiners can challenge the management outlined and the candidate is forced to defend himself or herself. This is seen as a test of character.

The changes to the orthodontic assessment reflect changes that have taken place in the learning experience. This process has already seen a move away from traditional essays. The use of multiple choice questions to assess students who have been taught on a PBL programme has been advocated (2), but we feel that knowledge is currently adequately assessed through the OSCE and short answer section. Tutors who are considering the move to a PBL course must also look at the methods of assessment. We would recommend using a range of assessment methods, with emphasis on the skills that PBL develops and a shift away from purely knowledge-based assessments. Although the dental educator may initially feel uncomfortable about potentially graduating students with less factual knowledge, our experience is that any small loss of knowledge is more than offset by producing future dentists who are able to take responsibility for lifelong learning and who can tackle clinical problems with greater aplomb.

Conclusion

This paper has described the development of assessment methods for students on the orthodontic undergraduate programme at the University of Manchester Dental School. Whilst the active learner must be assessed on their knowledge of their subject, traditional assessment does little to reward and encourage a variety of other skills which problem-based learning aims to develop. It is a challenge to educators to adapt assessment strategies to ensure that cognitive knowledge is tested, but the wider aspirations of problem-based learning are not forgotten and we hope that the examples given here show one way of approaching the problem.

References


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