A New Predoctoral Endodontic Module: Evaluating Learning and Effectiveness


Abstract: The teaching of advanced endodontic courses at the predoctoral level is common, but it can be difficult to assess teaching effectiveness. Advanced modules placed later in the dental curriculum provide the opportunity to introduce a new topic, revisit and reinforce concepts learned previously, and instill the notion of lifelong learning. At any level, the introduction of new techniques to novices must be based on recognition of their prior knowledge and experience and their need for explicit direction, stepwise instruction, and comprehensive feedback. Assessment of students’ performance should not only provide insights into what they know and can do, but also steer them towards desired outcomes. In addition, assessment can provide valuable feedback on teaching effectiveness. In this article, we describe a module piloted for inclusion in the University of Otago (New Zealand) fourth-year dental curriculum. This involved the use of tapered hand and rotary nickel-titanium files for root canal preparation and was taught through a didactic program (lectures and problem-based learning seminars) and a series of preclinical hands-on sessions. Findings from formative and summative assessments as well as student, peer, and self-evaluation indicated that the objectives of the module were met and that it was effective in both providing students with the basic skills for using this type of instrumentation and increasing their understanding and enthusiasm for endodontics. We conclude by discussing curriculum changes resulting from our module evaluation, directions for future research, and suggestions for teaching advanced endodontic techniques.

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leaning and shaping of the root canal system are integral to the treatment of endodontic infection, disease, and periapical healing. A preparation technique that facilitates early removal of microorganisms and ensures optimal disinfection best achieves this. With an increasing number of general dental practitioners using tapered files (especially rotary nickel-titanium) for root canal preparation, it is important that predoctoral students are equipped with understanding and preclinical experience in the use of these instruments.

Reports on predoctoral endodontic curricula have shown a wide variation in the way endodontics is taught and what competencies are expected; however, advances in using nickel-titanium technology and tapered files are seeing more universities adopt rotary instrumentation as part of the endodontic curriculum. In a survey of twenty-seven German dental schools, Sonntag et al. found that 63 percent of universities taught root canal preparation with rotary nickel-titanium instruments. Others have demonstrated that dental students are able to prepare curved root canals using rotary files with less transportation and greater conservation of tooth structure than when using hand-files.

Despite the gain in popularity, there has been limited research on implementing and introducing rotary instrumentation as well as differing opinions regarding when and how the material is best delivered within the dental curriculum. In a Swiss study from Zurich University, engine-driven rotary preparation techniques were taught during the third year of the predoctoral curriculum, whereas French schools have tended to provide lectures and preclinical training using the technique later in the curriculum. In a survey of sixteen dental schools, Arbab-Chirani and Vulcain found that, although teaching of rotary techniques for root canal preparation was part of the predoctoral curriculum, manual techniques continued to be taught, with nearly half the schools advocating the combined use of hand and rotary techniques. French dental students perceived rotary instrumentation to be easier, faster, and better than hand-filing techniques, although almost half of the students found the systems clinically unsafe due to the risk of iatrogenic errors.

Improvement in performance occurs as a student progresses through the learning process. This is a series of stages in which, through repeated practice, competence is achieved and performance is improved.
until it becomes accurate and automatic.⁰ Chambers identified five stages in the competence continuum, beginning with the early learner who is a novice, followed by beginner, competent, proficient, and expert.⁰ Students are novice learners who are hesitant and very reliant on faculty members for direction and prompt objective feedback. They require repeated practice at isolated tasks in an ideal setting, whereas beginners, although still requiring some guidance, are able to make some judgments and decisions and apply what they have learned.¹¹ Curriculum design and evaluation need to recognize that, when learning new techniques, novice dental students require explicit directions and instruction in small steps, as they work towards achieving competence in performing more complex tasks in clinical settings.¹²

In other areas of education, students’ learning has been shown to be enhanced through the provision of an initial summary of a topic.¹³ A search of the Scopus database for 1990–2010 failed to identify any published studies that have investigated the effectiveness of introducing a combined tapered hand and rotary technique or whether students benefit from having a background understanding of one endodontic technique prior to learning another. Furthermore, no studies examined whether the structure and delivery of didactic and preclinical components may improve the understanding of concepts students find difficult such as root canal transportation.

Accurate and comprehensive course evaluation is based on multiple data sources.¹⁴ Taken together, formative and summative student assessment data, student perceptions, teacher (self) evaluation, and peer evaluation can determine the effectiveness of teaching that has occurred.¹⁵ Assessment must have a clear purpose and be aligned to course objectives and content to determine students’ performance relative to the aims of the course. Together with other forms of evaluation (student formative and summative assessments), these serve different purposes and are integral to the endodontology curriculum within our school. In the early learning phase, formative assessment is beneficial for allowing practice and repetition and providing feedback on both teaching and learning.¹⁶⁻¹⁸ Provision of prompt feedback at this stage is crucial to the learning process as students often lack the skills to judge their own performance. This form of assessment contributes to learning,¹⁵ as students can perform, receive constructive feedback that encourages self-reflection, and improve skills without the concern of generating a grade.¹¹ Conversely, summative assessment grades are used to determine the final knowledge outcome and students’ understanding of content taught.

By examining student formative and summative assessment data alongside student course evaluations and self (teacher) and peer evaluation, we can triangulate evaluation data and gain a comprehensive picture of teaching effectiveness and student learning.¹⁶ Student evaluations may be valuable indicators of teaching effectiveness, but, as subjective feedback, they should be read alongside student assessment data.¹⁶,²⁰ Moreover, students may have limited insight into the expected goals and outcomes of a module, and the practical and professional value of student evaluations depends on the extent to which they are used to inform and improve teaching practice.²¹ Alongside student evaluations, teacher (self) and peer evaluation can be used to critically evaluate the teaching plan, objectives, and outcomes. Self-evaluation is not a commonly used assessment tool,¹⁶ but it provides the opportunity to reflect on teaching practices and a basis for responding to student assessment data and feedback. Some researchers have highlighted the bias that can result from this type of evaluation including overstating outcomes and the tendency to be either too lenient or too self-critical,¹¹,²¹ so concomitant peer evaluation can enhance self-reflection. The sharing of resources and ideas among colleagues can also highlight areas that need extra focus or modification in future teaching plans in order to make teaching more effective.¹⁶ To date, there have been no published studies pertaining to endodontic teaching that have combined the use of a student questionnaire with formative and summative assessment and self- and peer evaluation to assess teaching effectiveness. Most studies have relied on data from questionnaires or clinical outcomes.⁵⁻⁹,⁻²²⁻²⁴

In this article, we describe the development and evaluation of a pilot endodontic module for fourth-year dental students at the University of Otago, New Zealand. After a brief contextual explanation, we describe the module goals, objectives, and expected outcomes; the teaching and evaluation approach used; and module evaluation outcomes. We then discuss curriculum changes introduced as a result of our pilot study, directions for future research, and suggestions for advanced endodontic teaching at the predoctoral level.
Materials and Methods

The University of Otago predoctoral dentistry degree is completed over the course of five years. Our pilot module was introduced into the fourth year of the curriculum in 2009. The module involved the teaching of a pure crown-down preparation technique using variable-taper nickel-titanium (NiTi) hand and rotary files. In the previous year, these students had taken a preclinical endodontic course that used Gates Glidden drills and 0.02 taper NiTi hand-files in a crown-down modified step-back preparation technique. Otherwise, they had limited clinical experience in endodontic instrumentation.

Module Goals, Objectives, and Expected Outcomes

The primary goal of the module was to integrate tapered hand and rotary instrumentation techniques into endodontic teaching within the Faculty of Dentistry, with the objective of providing evidence-based knowledge and understanding of a pure crown-down preparation technique for the management of pulp and periapical disease, together with the clinical skills involved in its use. At the completion of the module, the students were expected to demonstrate knowledge and understanding of the biological basis of this preparation technique, progress towards competence in the preclinical use of tapered NiTi files for the preparation of curved root canals in simulated acrylic resin blocks and natural extracted teeth, understand the factors contributing to iatrogenic errors including root canal transportation and file fracture, and be able to critically evaluate treatment outcomes in a simulated environment. These objectives satisfy the European Society for Endodontology undergraduate curriculum guidelines.  

The class was comprised of seventy-three students: thirty-seven male and thirty-six female. The module was introduced in the second half of the students’ fourth year. The timing of the module meant that students had already experienced didactic endodontic teaching as well as clinical experience with hand-files. It was also intended to allow time for students to improve their skills and gain further experience in advanced endodontic techniques during their final (subsequent) year. The module had several components: lectures, a seminar, and a hands-on preclinical simulation course. These were taught and overseen by the same endodontist (LF) with clinical support from postgraduate endodontic students.

Lectures, Seminar, and Hands-On Preclinical Course

Didactic teaching sessions consisted of two ninety-minute lectures and a problem-based learning seminar session. Throughout these didactic sessions, case selection and treatment planning were emphasized. The class received handouts of slides shown during the presentations, electronic access to the video demonstrations, and supplementary references pertaining to tapered preparation techniques, rotary endodontic instrumentation, and the ProTaper system.

Preclinical teaching of tapered techniques was broken down into detailed steps. The module involved three two-hour preclinical sessions, with each task building on the previous. Tasks were initially taught on artificial plastic blocks with a 30 degree simulated curved root canal (Nissin Dental Product Inc., Kyoto, Japan) and later extracted human teeth (Table 1). At the beginning of each session, a live teacher demonstration was given, and video demonstration was available within the clinic. Students worked in pairs with a 1:7 staff to student ratio.

The ProTaper system consists of six variable tapered files: three are used for shaping the coronal portion of the root canal, and the remainder are finishing files for the apical third. Files are designed to be used either by hand or as a rotary file in a

<table>
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<tr>
<th>Table 1. Preclinical tasks</th>
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<tr>
<td>Task 1</td>
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<td>Task 2</td>
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<td>Task 3</td>
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torque-controlled handpiece. Students began with the use of hand-files using a balanced-force rotation movement that had not been taught previously within the endodontic curriculum. This technique was either used alone or in a hybrid manner combined with rotary files. Appreciating that students learn best with tasks broken into small steps, we asked students to decoronate teeth at the level of the cemento-enamel junction. This minimized the difficulty of working through an endodontic access cavity and ensured straight-line access to the root canal orifices, allowing students to primarily focus on the instrumentation technique within the root canal. Teeth were radiographed with a file in place to establish working length and then prepared using either a pure rotary technique or a hybrid technique, depending on the curvature of the canal. Following instrumentation, the teeth were again radiographed as a basis for evaluating the preparation.

Assessment and Evaluation

Educational assessment is not an exact science, but as Manogue et al. state, “A judgment or measurement of worth [based on] a sample of behaviors, . . . inferences, and . . . estimates.” Best practice guidelines in dental education suggest that assessment should ideally balance reliability, validity, and practicability in order to examine students’ performance of required tasks and readiness to proceed to more complex tasks. We sought to ensure the reliability and validity of formative assessment through the use of explicit assessment criteria based on current endodontic practice guidelines as an objective basis for judging students’ work. In addition, we sought to ensure the fairness of summative assessment by examining the resulting grade distribution. However, our approach to assessment and evaluation was also informed by sociocultural perspectives that highlight the inevitable role of interpretive judgment in determining whether or not students meet objective criteria; the importance of assessment as a way of promoting (not just measuring) students’ learning and a basis for feedback on both learning and teaching; and the influence of context on teaching, learning, and professional practice. Thus, we sought to gather consistent, fair, accurate, and comprehensive evaluative data by using multiple forms of assessment and ensuring that all assessment approaches were aligned with the module objectives and content. In addition, we included assessment approaches aimed at examining students’ subjective responses to the learning context: their learning experiences within the module, attitudes to endodontics after engaging with the module, and sense of confidence as emerging professionals.

Specifically, we evaluated the endodontic module using five data sources. These were:
1. a student perception questionnaire;
2. formative assessment, including student self-assessment and teacher assessment;
3. summative assessment that examined students’ knowledge and understanding;
4. teacher self-evaluation of the module; and
5. peer evaluation of the module.

The student perception questionnaire was given to those students who had completed all didactic and preclinical tasks and who also agreed to anonymously record their perceptions and experiences of the module at its conclusion. Questions asked students to describe their background knowledge and clinical experience; reflect on lecture material and resources used throughout the module; discuss their perspectives on the preclinical teaching methods used, the different endodontic techniques used, and their confidence integrating the techniques for patient care; and indicate whether the module had stimulated their interest in the field of endodontics. Responses used a four-point Likert scale from strongly agree to strongly disagree or very easy to very difficult. The questionnaire also asked a series of open-ended questions regarding the specific difficulties encountered completing preclinical tasks and the advantages and disadvantages of using tapered hand and rotary systems within the current endodontic curriculum. Questionnaire content is outlined in Table 2. The student perception questionnaire was aimed at eliciting in-depth, information-rich, and contextually relevant qualitative data on students’ perceptions of the module and endodontics generally and learning experiences within the module.

Formative assessment involved both self- and teacher assessments of the students’ work and was intended to do two things: provide immediate and comprehensive feedback to students on their performance against explicit criteria, and prompt students to evaluate their own work against the same criteria. “Ideal performance” was discussed and demonstrated prior to students’ completion of set tasks. Students were asked to critically evaluate their preclinical preparations and compare them with the teacher demonstration model of the task. Prompt feedback was given by staff, and a combined formative assessment by the student and teacher decided whether the task
was performed to a standard that was satisfactory, could be improved, or was unsatisfactory. Summative assessment involved the inclusion of a theoretical question in the final written examination querying the rationale behind techniques used to prepare curved root canals using tapered nickel-titanium files. This was intended to assess students’ knowledge and understanding of components of the module.

Following the module, the module coordinator (LF) used anonymous student perception questionnaire feedback, preclinical simulation tasks, and formative and summative assessment outcomes as a basis for self-evaluation. Self-evaluation involved reflection on the teaching plan, practices, learning outcomes, and perceived effectiveness of the module. A faculty dental education advisor (VA) provided further feedback on the module in terms of its stated goals, competencies, intended outcomes, and assessment approaches.

Data Analysis

We used both qualitative and quantitative analysis as a basis for evaluating the module. Descriptive analysis was used for peer and self-assessment data and emerging themes identified in student perception questionnaire response items. Differences in proportions were quantified with the chi-square test. We then considered the results of all data sources in the light of our initial learning objectives and formative and summative assessment results.

Results

The new endodontic module was evaluated using data from multiple sources. In the class of seventy-three, fifty-four students (74 percent) agreed to answer the questionnaire and had completed the didactic and preclinical parts of the module. Almost all students had limited prior clinical endodontic experience, which had been restricted to the use of hand-files. Seven (13 percent) had treated ten root canals, forty-three (79 percent) ten to fifteen canals, and four (7 percent) sixteen to twenty canals. Only one student had treated twenty canals.

Data from the student questionnaire are presented in Table 2. The overall response to the module was positive, with 87 percent of students either strongly agreeing or agreeing that it had stimulated their interest in NiTi tapered hand and rotary instrumentation, and a similar percentage responding that it had stimulated their general interest in endodontics. Of significance, 96 percent of students who agreed that they had sufficient basic endodontic knowledge prior to the module also agreed that it had stimulated their interest in endodontics (p=0.005). Almost all students agreed that lecture material, handouts, expert

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly Agree (%)</th>
<th>Agree (%)</th>
<th>Undecided (%)</th>
<th>Disagree (%)</th>
</tr>
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<tbody>
<tr>
<td>I think I have sufficient basic knowledge of endodontics prior to undertaking this module.</td>
<td>17 (31%)</td>
<td>28 (52%)</td>
<td>8 (15%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>The ProTaper video demonstration supported my learning.</td>
<td>34 (63%)</td>
<td>9 (17%)</td>
<td>11 (20%)</td>
<td>0</td>
</tr>
<tr>
<td>The lecture material and preclinical simulation handouts were required to fully benefit from the module.</td>
<td>39 (72%)</td>
<td>14 (26%)</td>
<td>1 (2%)</td>
<td>0</td>
</tr>
<tr>
<td>I was given adequate demonstration and instructions before the preclinical tasks.</td>
<td>41 (76%)</td>
<td>12 (22%)</td>
<td>1 (2%)</td>
<td>0</td>
</tr>
<tr>
<td>The video demonstration in the clinic while doing the preclinical tasks helped me understand the techniques better.</td>
<td>30 (56%)</td>
<td>11 (20%)</td>
<td>11 (20%)</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>The simulated curved canals in acrylic resin and extracted human teeth were sufficient to give me the basic skills for NiTi tapered hand and rotary instrumentation.</td>
<td>39 (72%)</td>
<td>13 (24%)</td>
<td>2 (4%)</td>
<td>0</td>
</tr>
<tr>
<td>The module stimulated my interest in NiTi tapered hand and rotary instrumentation.</td>
<td>40 (74%)</td>
<td>7 (13%)</td>
<td>7 (13%)</td>
<td>0</td>
</tr>
<tr>
<td>The module stimulated my interest in the field of endodontics. NiTi=nickel-titanium</td>
<td>24 (44%)</td>
<td>24 (44%)</td>
<td>5 (10%)</td>
<td>1 (2%)</td>
</tr>
</tbody>
</table>

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demonstrations, and instructions were required to fully benefit from the module; however, 24 percent were either undecided or did not agree that the video demonstration during the clinical sessions helped with their understanding of techniques or task performance. Live expert demonstration by the supervising endodontist (LF) was the preferred method for learning the techniques. It was generally accepted that the hands-on preclinical course using acrylic blocks and extracted teeth provided students with the basic skills for NiTi tapered and hand instrumentation, but only 39 percent of the respondents felt they had the confidence to use these techniques on patients, with the remainder either undecided (50 percent) or not confident (11 percent). This is reflected in responses to the open-ended questions in which students made repeated comments like the following: they “wanted more simulation time and practice” and “would have benefitted from ‘life-like’ practice on extracted teeth mounted in a simulator rather than the bench-top.” Despite these remarks, almost all students found the tapered preparation techniques more straightforward than the crown-down step-back technique. As one student stated, the tapered technique was “simpler and less complicated, faster, and gave a closer to ideal taper than the preparation technique they routinely performed on patients.”

The combined student and teacher formative assessments for each of the three simulation tasks showed that twenty-eight (51.9 percent) of the hand-prepared canals were unsatisfactory, while seventeen (31.5 percent) of the rotary-prepared canals were unsatisfactory ($\chi^2=7.53; 2$df; $p=0.023$). A summative assessment grade for the module resulted in a mean of 63 percent (standard deviation 1.5), and grades were normally distributed.

Teacher (self) and peer evaluation were based on student formative and summative assessment data, student feedback, teacher observation, and teacher reflection. Key findings were as follows:

1. Breaking tasks into distinct components facilitated learning.
2. Students demonstrated an understanding of the need to integrate theoretical concepts clinically to a high level for a desirable root canal preparation. Specifically, consideration and causes of canal transportation appeared better understood than with our previously taught instrumentation techniques.
3. The majority of students appreciated the importance of appropriate case selection and treatment planning for favorable treatment outcomes and also that continued practice with the instruments is necessary before progressing to their clinical use on patients. From a teaching perspective, it was evident that as the students’ preclinical time increased, the increased practice and confidence resulted in improved competencies and more satisfactory outcomes.
4. The competency-based formative assessment with non-graded feedback allowed students to learn through practice. Furthermore, the opportunity for students to evaluate and improve on their own and each other’s work without the stress of a grade promoted a collegial clinic environment. Students responded well when provided with immediate feedback and combined formative assessment. Even those students who had performed well worked to improve their performance after feedback.
5. Extra preclinical time within the module should be provided in the future, including additional tasks working through an endodontic access cavity.

Discussion

Assessment of the module was closely aligned with the stated objectives. The emphasis on formative assessment and the use of endodontic faculty members to oversee didactic and clinical components were intended to motivate students and promote their ongoing learning through problem-solving, reflective practice, and faculty feedback. The self-assessment of clinical tasks promoted students’ active involvement in the evaluation process alongside teacher and peers, and facilitated an apparent determination to improve that may have contributed to the increased enthusiasm for endodontics students reported at the end of the module. The summative assessment grade was derived from a written examination integrated with other disciplines so, although the average grade reflected an understanding of module concepts, it is only useful in an evaluative sense when considered alongside the other types of assessment. The depth of feedback gained from multiple types of assessment suggests that such an approach may be usefully applied to inform and improve teaching practice in other areas of our endodontic and dental curricula.

When planning the module, we adopted a similar incremental approach to that used in other areas of dental education. We recognized the knowledge and skills that the students require to progress towards competence in this area of endodontics, the
weaknesses in student understanding, and commonly made clinical mistakes. Our program and evaluation acknowledged the characteristics of the novice learner by providing isolated tasks as a foundation for later performance.\textsuperscript{12,26,27} The use of lectures and preclinical practice or learning were in line with other programs that have introduced this technique,\textsuperscript{5,22-24} but we also had a problem-based learning tutorial as part of the didactic program to facilitate the link between theoretical and clinical understanding.\textsuperscript{35} Within the preclinical program, the introduction of tapered hand techniques prior to rotary ones and then progression to natural teeth allowed repeated practice and learning opportunities. Students’ skill acquisition evidently improved through repeated teacher demonstration, mishaps, encouragement, and feedback. This was especially useful in enabling students to better appreciate iatrogenic errors associated with treatment and how to avoid them.

The use of hand-held models (rather than mounts within a mannequin on a dental simulator) may be seen as a shortcoming of the teaching approach used; however, there are inherent difficulties in mounting small resin blocks or natural teeth within the mannequin jaws. Although not ideal, the preparation of artificial teeth for endodontic teaching is common practice, offering students the ability to acquire clinical skills required for treating root canal curvatures without the ethical constraints associated with the use of natural teeth.\textsuperscript{38}

A methodological consideration was the limited number of preclinical tasks included in the module, but unfortunately, due to time constraints within our dental curriculum, extended preclinical time was not possible in 2009. Although the time we dedicated to preclinical tasks was similar to programs introduced elsewhere,\textsuperscript{22,23} in view of the teacher (self) reflection and peer and student feedback, the preclinical component of the module will be extended and expanded in the future. Specifically, instrumentation through an endodontic access cavity (which is critical to a favorable endodontic outcome) will be incorporated into the module. This will enable students to appreciate how access cavities may need to be modified to permit the use of rotary files while enabling more practice and repetition prior to clinical performance.

The findings of our pilot study have led to the introduction of increased and earlier endodontic experiences in our predoctoral curriculum. Introduction to endodontic teaching will begin earlier in the third year of the dental curriculum, and from 2011 a tapered hand technique will be taught. Furthermore, students will be assigned more complex clinical cases earlier. The advanced module will remain in the fourth year; however, starting in 2010, preclinical time was increased.

Hand-files give a better tactile sensation than rotary instruments and may be safer in many clinical situations. This is especially true in a learning environment, so we do not recommend the replacement of hand technique courses with a rotary course. The introduction of the rotary when students have some hand skills is preferred, and we believe implementation later in the course is favorable. In common with several European dental schools,\textsuperscript{5,9} we advocate the combined use of hand-files in association with rotary instruments for preparation of root canals.

Our study may have limitations. The exclusion of those students who had not completed all components of the module (such as lectures, tutorial, and preclinical tasks) may be considered a limitation, but others have shown that theoretical understanding is fundamental to improved clinical practice using NiTi instrumentation\textsuperscript{22-24} and the omission of these students minimized discrepancies in student responses. Since students submitted their questionnaires and preclinical simulation tasks anonymously, summative assessment was not matched to an individual’s preclinical work. Moreover, because the module was a compulsory part of the fourth-year curriculum, including a control group was neither possible nor ethical. As a result, we do not know from this study whether prior learning affected students’ acquisition of motor skills and understanding. However, as was found by Arbab-Chirani and Vulcain,\textsuperscript{5} our students perceived the tapered techniques to be easier to learn than the modified crown-down step-back technique they had been taught in their third year. This may reflect their prior knowledge.

The correlation between prior background knowledge and an increased interest in endodontics following the module is interesting and may lend support to the findings of Ausubel.\textsuperscript{13} He argued that, for understanding to occur, the content must be potentially meaningful and the learner must relate it in a meaningful way to his or her prior knowledge. Prior endodontic knowledge, together with the reinforcement of core concepts during the module, apparently facilitated our students’ readiness to question, make judgments, and think critically about endodontics.

The true effect of their greater interest in endodontics and the module’s impact on clinical endodontic care can only be measured by following students in their final year. Students will be encour-
aged to pursue more preclinical practice to improve their competence and then to use these techniques clinically. In a supervised environment (and with appropriate case selection), they can further improve their clinical skills and understanding in the use of tapered instrumentation systems for the preparation of root canals. This continuing education with objective feedback will help reduce the dilution of knowledge and clinical competence gained from the module. As participating students progress into their final year of study, we intend to examine the number, quality, and complexity of cases that they treat in comparison with those treated by previous groups of final-year students.

Conclusion

This study reported on the development and evaluation of a pilot tapered hand and rotary endodontic module for predoctoral dentistry students at the University of Otago, New Zealand. Study findings reinforced the value of teaching approaches that recognize the characteristics of early novice learners, provide comprehensive formative feedback, promote student self-reflection, and are aligned with program goals and objectives. Multiple sources of assessment data allowed us to comprehensively evaluate the teaching practices used.

REFERENCES