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Title:

USE OF PROGRESS TESTING IN DENTAL THERAPY AND HYGIENE EDUCATION

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ABSTRACT

Purpose: To share the experience of developing progress testing in an undergraduate program for dental therapy and hygiene students as the main tool for academic assessment. **Methods:** Data were collected for progress tests conducted from 2015-17. Each test comprised 100 single best answer multiple-choice items with accompanying vignette. The students chose their answer from five options. A score of 1 mark was awarded for each correct answer; -0.25 for an incorrect answer, and 0 for 'Don't Know' (DK). The standard for each assessment was derived using a combined Angoff-Hofstee approach. **Results:** Three cohorts were included in this study and seven progress tests were conducted in total over a period of three years. Analysis of performance shows growth in knowledge across successive years with the largest increase in knowledge observed during transition from Year 1 to Year 2 and concomitant reduction in incorrect and DK responses. **Conclusions:** This is a pioneering study to report the establishment and use of progress testing in an undergraduate dental therapy and hygiene curriculum. Notwithstanding the challenges involved, there is merit in exploring the use of progress testing in dental hygiene and therapy curricula further.

Key Words: Assessment; Dental; Education; Hygiene; Therapy

INTRODUCTION

Progress testing is aimed at a longitudinal assessment of the development and sustainability of knowledge at regular intervals over the duration of an educational program, predicated on a frequent-look rapid-remediation philosophy. The key objectives of progress testing are to provide repeated and comparable integrated assessments across the range of topic areas covered throughout the duration of a program.¹ Comparisons of performance on successive tests are used to monitor growth in knowledge. The results of these are combined to determine the growth of knowledge for each student, enabling more reliable and valid decision making about progression to later phases of study². The regularity and frequency of testing allows early recognition of learning needs of the students and provides structured feedback that can be discussed with academic tutors.

Progress testing was first used to assess the knowledge of undergraduate medical students.^{3, 4} It is now firmly established as a recognised form of assessment in undergraduate medical curricula.⁵⁻⁹ Our dental school was the first to use progress testing in its Bachelor of Dental Surgery (BDS) program.^{10, 11} Subsequently, we have implemented progress testing in a joint undergraduate program for Dental Hygiene and Therapy (DTH).

The aim of this paper is to share our experience of developing progress testing for use as a major tool for the academic assessment of DTH students over a three-year period.

Dental Therapy and Hygiene Program

Peninsula Dental School introduced its first cohort of Dental Therapy and Hygiene (DTH) students in September 2014. Changes to regulations regarding Direct Access to Dental Care Professionals (DCPs) were announced by the General Dental Council (GDC) in 2013.¹² These changes based on a consensus for shared care, drove the school to develop a new innovative program to address the changing demands of dentistry and tackle related issues within the profession today. The DTH and Bachelor of Dental Surgery (BDS) programs are fully integrated in the first year of the course and have been designed to encourage inter-professional learning and effective teamwork from the very start.

This approach has been adopted to overcome barriers to inter-professional working which traditional programs experience. These barriers not only inhibit teamwork and communication but also create a hierarchical working culture. Embedding teamwork into each day of the program creates understanding and respect for each other's roles, leading to greater utilization of team members' skills and aiming to improve patient care.

As both programs share learning outcomes and overlap in their scope of clinical practice, teaching sessions and assessments are designed to support and enhance inter-professional education. This simulates the way in which dentists, dental hygienists and therapists interact in clinical practice.

Academic sessions consist of Enquiry Based Learning (EBL) supported by interactive small group sessions, plenaries, workshops and self-directed learning.

This provides students ample opportunities to discuss shared care, scope of practice, and their roles within the dental team. Students learn and share their clinical skills in the Simulated Dental Learning Environment (SDLE) and progress onto the clinical environment together where they are encouraged to work in a team. Where their teaching differs, or elements of clinical practice extend beyond the DTH Scope of Practice, the focus changes from shared content learning, to team-based teaching and learning. This allows students to explore profession-specific issues, and to gain a sense of professional identity and a place within the team.

As DTH students progress through the program, their clinical experience increases from one day per week in Year 1 to four days per week in Year 3. Senior cohorts of both DTH and BDS programs work alongside each other gaining experience on planning and managing patient cases together, preparing them for general practice and the future dental profession.

Progress Testing in the Dental Hygiene and Therapy Program

The progress tests are aimed at assessing Applied Dental and Therapy Knowledge (ADTK) and are administered on three occasions annually (once per term). Each progress test is standard set to the level expected from newly qualified dental hygienists and therapists as outlined by the GDC¹³, and progress is indexed by a steady increase in scores achieved. DTH students in Years 2 and 3 are required to sit all three tests and their performance of these tests contributes to their progression in the program as explained later. DTH students in Year 1 only sit one formative test during the last term. Therefore, each cohort sits seven progress tests during the DTH program.

Each test is based on 100 single best answer (SBA) multiple-choice items. Each question is using an appropriate dental vignette setting the test item within a clinical context. The questions are aimed at testing the application, analysis, and synthesis of knowledge rather than simple factual recall. Each question has five responses and a 'Don't Know' (DK) option but only one correct answer. A score of 1 mark is awarded for each correct answer; -0.25 for an incorrect answer, and 0 for 'Don't Know'.

Test Production

A question bank has been developed in-house for the DTH program and all questions undergo a multi-stage quality assurance process before final inclusion in the bank. New questions are initially reviewed by senior academics and clinicians. Questions deemed to be appropriate are then submitted to a Dental Question Writing Group (DQWG) which considers all details of each question before acceptance; questions remain subject to further scrutiny during pre-test and post-test meetings which serve the purpose of reviewing items before assessments are produced and evaluating item performance after students have completed the assessment respectively. The entire question bank and individual progress tests are mapped against the learning outcomes for hygienists and therapists under four key domains: (1) Clinical; (2) Communication Skills; (3), Professionalism and (4) Management and Leadership skills. A blueprint for each test is produced to ensure the items measure a representative sample of the curriculum content and match to specific learning outcomes for the DTH program. Approximately 50% (N=50) test items are allocated to the clinical domain; 10% (N=10) to communication skills; 15% (N=15) to professionalism; and 15% (N=15) to the management and leadership domain. The allocation of test items broadly mirrors the weighting of the four domains in the

learning outcomes for the DTH program. Moreover, the test blueprint also serves to identify any duplicate items. The aim is to assess applied knowledge related to all learning outcomes amenable to assessment in a multiple-choice examination format over the course of the program.

Standard Setting

The standard of the questions is benchmarked against the knowledge expected from newly qualified dental hygienists and therapists. The standard expected of a new graduate is set by a combination of criterion- and norm-referencing using a combination of the Angoff and Hofstee methods.^{14, 15}

A panel of experienced faculty members determines the difficulty level for each question in a test by indicating if a borderline (minimally capable) student is expected to answer the question correctly. (Angoff method). The academics also indicate the minimum and maximum pass marks along with minimum and maximum failure rates acceptable for a given test (Hofstee method).

The ratings are averaged across panel members for each item and then summed to obtain a panel-recommended cut-off score which represents the score expected from a minimally competent candidate (Year 3, newly qualified DTH graduate). The standard setting is then deliberated further in a group setting during a “Moderation” meeting to finalise the cut-off score for Year 3. The cut-off score for Year 2 is lower than Year 3 to account for differences in difficulty and variance between the two cohorts. The Year 3 cut-off score can be converted to a z-score which expresses the number of standard deviations the pass mark is away from the Year 3 mean. The

Year 2 standard is placed relative to the Year 2 mean at the same number of standard deviations.

Grade boundaries for 'Unsatisfactory', 'Borderline', 'Satisfactory', and 'Excellent' are then constructed for individual tests. These grade boundaries are based on a combination of cut-scores, mean cohort performance, and standard errors of measurement (SEM) as explained in Appendix I.

Progression of Students

The DTH curriculum has a modular structure and the students are required to pass all the modules in each year before progressing to the next stage. Individual test grades are combined to produce an “*End of Year*” aggregate grade of *Satisfactory*, *Borderline* or *Unsatisfactory* at the end of Year 2. These aggregate grades are used for decisions on passing the module. Because of the progressive nature of the testing, Year 2 students who progress to Year 3, carry forward their end-of-year aggregate grade. After each subsequent test in Year 3, the aggregate grade is combined with the test grade to provide a new aggregate grade. Students who retake a year commence the repeat year with the aggregate grade from the end of their most recent successful year. An overall “Module grade” of Excellent, Pass, or Fail is awarded based on the final aggregate grade in Year 3.

Feedback

A key element of progress testing is to provide immediate and comprehensive feedback on performance to the students. Feedback to the students includes grade boundaries, individual test scores, and grade. Moreover, students receive their

ranking within the cohort, progress in relation to previous sittings and details of correct, incorrect, and DK responses. As part of the feedback, a short statement outlining the main learning outcome being addressed by each test item is also provided along with the student's response to that item.

METHODS

Ethical approval for this study was obtained from the Institutional Review Board (Number 16/17)-695). Examination data related to seven progress test sittings conducted over a period of three years (2014-17) for undergraduate DTH students was collated.

Setting: Peninsula Dental School, Plymouth, United Kingdom

Participants: The study population consisted of three cohorts of undergraduate DTH students.

Data Analysis

Analyses of data were undertaken using the R statistical language and environment.¹⁶ Analyses include simple descriptive statistics and distribution plots, reliability measures, demographic analysis and classical test theory based item analyses.¹⁷ This information is used at post-test meetings to review the standards of the assessment and identify items for review and possible exclusion. While statistical analyses guide the assessment, the decision to remove any item is at the discretion of subject experts attending the post-test meeting.

RESULTS

The 2014-15 cohort (N=09) sat seven progress tests; the 2015-16 cohort (N=11) sat four progress tests; and the 2016-17 cohort (N=18) only sat one formative test in 2017.

Table 1 shows the mean scores out of 100 marks achieved on each test occasion, averaged across all cohorts. It also shows the mean percentage of 'Correct', 'Incorrect', and 'Don't Know' responses.

Progress of DTH students in 2014-15 and 2015-16 cohorts is depicted in Figure 1 and Figure 2 respectively. It shows growth in knowledge of students as indicated by increase in correct responses and a reduction in "incorrect" and "don't know" responses for the cohort in successive years. The differences between the Year 1 and Year 2 were particularly noticeable which coincided with increased clinical exposure of the students. The overall test retest reliability for the seven sittings in this data set was 0.76.

DISCUSSION

This is the first study to report the establishment and use of progress testing as the principal form of knowledge assessment in an undergraduate dental hygiene and therapy program. Progress testing offers several advantages compared to traditional yearly assessments. Firstly, testing at regular intervals over the course of an educational program allows close monitoring of the growth in applied knowledge. Setting the standard of questions at the level of a new graduate, progress testing facilitates assessment of the learning outcomes of an educational program in an integrated manner. Moreover, use of appropriate vignettes in questions provides context and relevance to clinical practice which may enhance students' motivation for learning the facilitates student's ability to generalise this knowledge to clinical settings. Test items based around a carefully constructed clinical vignette are more likely to achieve this than non-contextualised test items.¹⁸

Assessment of functional knowledge encourages the students to acquire information and develop understanding breaking the link between learning and revision. Therefore, it may serve to break the relationship between the taught program and assessment.³ Traditional methods involving subject-based assessments at the end of each module or academic year may promote surface and rote learning of facts. Finally, progress testing provides vastly superior opportunities for feedback for internal and external evaluations. It allows students and their academic supervisors to identify the learning needs of individual students to improve their applied knowledge in subsequent years. ^{2, 3, 19}

Development and use of progress testing is a labour and resource-intensive task. Development of a suitable question bank, multiple test administrations, and psychometric analyses of data requires considerable faculty time.³ Moreover, students in early years may find the assessment challenging due to limited knowledge. Nevertheless, appropriate guidance and support by the academic staff may help to moderate students' expectations in the first year. We aim to avoid repetition of questions for a given cohort for the entire duration of the program. Preparation of test items in sufficient numbers to populate repeated tests is time consuming and has placed a considerable load on the staff involved in progress testing for the DTH program. Unlike Medicine, there are no shared banks of DTH questions from which test items can be drawn¹⁵. Perhaps future collaboration amongst institutions providing dental hygiene and therapy education may facilitate the development of shared question banks to overcome this challenge, and provide new and interesting opportunities for developing and evaluating teaching and feedback.

The results of this study demonstrate growth in applied knowledge of DTH students as reported previously for undergraduate medical and dental students.^{5, 6, 11} The Year 1 mean score was 35. 57 which may appear to be high. However, it needs to be reiterated that Year 1 take their first test in the last term by which time they have not only had a substantial proportion of their pre-clinical teaching in simulated dental environment (SDLE) but also start seeing patients in clinic. Moreover, some DTH students also have previous qualifications and experience including dental nursing. These factors may explain the apparently high score in Year 1. Within our data set, the growth in knowledge was most remarkable during transition from Year 1 to Year

2, gradually reaching a plateau in Year 3. This may be related to the progress tests becoming a high-stake examination and a requirement to pass Year 2. Moreover, increased clinical exposure could also contribute to greater ability to apply knowledge to MCQ vignettes and clinical problem solving.

Use of negative marking for incorrect responses with a penalty of -0.25 marks per incorrect response is consistent with the practice for the undergraduate medical and dental progress tests in our institution.⁵ This approach is in line with our sister medical school.²⁰ Although negative marking is not used consistently in progress testing, the rationale is to discourage guess work by students which may potentially lead to falsification of test score. This may be appropriate for specialised assessments like progress testing while a “number right” (scores based on right answers only) may be preferred for normal achievement tests.²¹ Inclusion of a “don’t know” option is aimed at reinforcing the need to recognise personal limitations in knowledge in clinical practice. This self-awareness is an important element of professionalism and patient safety. However, further research is required to evaluate the practice of negative marking in progress testing. Such research may involve qualitative interviews with the students in order to gain an understanding of their perceptions and approaches to negative marking.

Progress testing on multiple occasions in each academic year generates large amounts of data which can be used to provide feedback.²² The students at our school are required to reflect on their performance with their academic tutors at portfolio appraisals (RPAs) once per term. In addition, students receiving an unsatisfactory or borderline grade in a progress test are offered remediation and

study skills courses to bridge the gaps in their learning; a task which the item-by-item and cumulative domain-level feedback helps to support.

A limitation of our findings is the small sample size and therefore, the results need to be interpreted with a degree of caution. Nevertheless, we utilise several measures to evaluate the validity and reliability of progress testing for DTH students. External validity is contributed to by involvement of subject experts and academics in the development and review of progress testing; blueprinting of questions to GDC learning outcomes; and review by the external examiners. Predictive validity of progress testing has also been reported previously.² We run a number of different analyses, including looking at descriptives (mean, standard deviation, minimum, maximum, median, interquartile range – overall and within cohorts); distributions including outliers (overall and within cohorts): proportions of response types within and between cohorts and tests; analysis of item facilities and response rates (within and between cohorts); differences in item facility between first and final stage students ('growth'); and scrutiny of response patterns (frequencies and proportions of each response option chosen) by students in each stage for each item. These analyses are used to give a statistical overview of the test, item, and cohort performance. The overall test-re-test reliability currently averages at $r=0.76$ indicating satisfactory reproducibility of the test and low level of random measurement error. It is acknowledged that a larger sample size would be ideal to perform more robust statistical analyses. We are hopeful that if other institutions involved in DTH education adopt progress testing in the future, it may be possible to undertake further analysis of test properties.

A variety of pedagogic approaches are used in DTH curricula. Evidence from the literature shows that educational programs in dental hygiene are incorporating evidence-based approaches in teaching and learning.²³⁻²⁶ However, limited published literature is available on the assessment methods employed to assess knowledge for DTH students. Progress testing serves as a useful longitudinal assessment tool to compare the growth in applied knowledge between different schools. However, further research is required to explore the feasibility and benefits of progress testing in DTH education. The authors welcome contact from those involved in other DTH programs nationally and internationally.

CONCLUSIONS

Progress testing is a useful assessment tool to measure growth in applied dental hygiene and therapy knowledge and offers tremendous opportunities for structured feedback to address individual learning needs. Notwithstanding the challenges related to faculty time and resources, there is merit in considering the use of progress testing in dental hygiene and therapy programs.

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Conflict of Interest

None of the authors have any conflict of interest to declare

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Table 1 Performance of students in progress tests

Test Occasion*	Cohorts Aggregated**	Mean Score	SD	Response Type Proportion (%)		
				Correct	Incorrect	Don't Know
1	2014-15, 2015-16, 2016-17	35.57	10.90	44.25	34.77	20.98
2	2014-15, 2015-16	53.92	7.66	59.85	23.73	16.42
3	2014-15, 2015-16	52.01	4.07	58.57	26.23	15.20
4	2014-15, 2015-16	59.88	6.33	65.05	20.69	14.27
5	2014-15	69.31	2.97	74.11	19.22	6.67
6	2014-15	63.19	7.33	68.91	22.90	8.19
7	2014-15	67.56	5.94	72.45	19.56	7.99

**Test 1 conducted in Year1; Tests 2, 3 and 4 in Year 2; and Tests 5, 6 and 7 in Year 3*

***Sample sizes for each cohort: 2014-15 n=9; 2015-16 n=11; and 2016-17 n=18*

Figure 1
Graph

illustrating performance of students in the 2014-15 Cohort. Growth in knowledge over seven progress test sittings is indicated by increase in correct responses

Figure 2 Graph illustrating performance of students in the 2015-16 Cohort. Growth in knowledge over four progress test sittings is indicated by an increase in correct responses

REFERENCES

1. Schuwirth LW, van der Vleuten CP. The use of progress testing. *Perspect Med Educ.* 2012;1(1):24-30.
2. Schuwirth L, Bosman G, Henning R, Rinkel R, Wenink A. Collaboration on progress testing in medical schools in the Netherlands. *Med Teach.* 2010; 32:476–9.
3. Van der Vleuten CPM, Verwijnen GM, Wijnen WHFW. Fifteen years of experience with progress testing in a problem-based learning curriculum. *Med Teach.* 1996; 18:103–10.
4. Blake JM, Norman GR, Keane DR, Barber Mueller C, Cunningham J, Didyk N. Introducing progress testing in McMaster University's problem-based medical curriculum: psychometric properties and effect on learning. *Acad Med.* 1996; 71:1002–7.
5. Freeman A, Ricketts C. Choosing and designing knowledge assessments: experience at a new medical school. *Med Teach.* 2010; 32:578–81.
6. Nouns Z, Georg W. Progress testing in German speaking countries. *Med Teach.* 2010; 32:467–70.
7. Tomic ER, Martins MA, Lotufo PA, Benseñor IM. Progress testing: evaluation of four years of application in the school of medicine, University of São Paulo. *Clinics (Sao Paulo).* 2005; 60(5):389-96.
8. Al Alwan I, Al-Moamary M, Al-Attas N, Al Kushi A, AlBanyan E, Zamakhshary M, Al Kadri HM, Tamim H, Magzoub M, Hajeer A, Schmidt H. The progress test

- as a diagnostic tool for a new PBL curriculum. *Educ Health (Abingdon)*. 2011; 24(3):493.
9. Aarts R, Steidell K, Manuel BAF, Driessen EW. Progress testing in resource-poor countries: a case from Mozambique. *Med Teach*. 2010; 32:461–3.
 10. Bennett J, Freeman A, Coombes L, Kay L, Ricketts C. Adaptation of medical progress testing to a dental setting. *Med Teach*. 2010; 32(6):500-2.
 11. Ali K, Coombes L, Kay E, Tredwin C, Jones G, Ricketts C, Bennett J. Progress testing in undergraduate dental education: the Peninsula experience and future opportunities. *Eur J Dent Educ*. 2016; 20(3):129-34.
 12. GDC announces controversial decision on direct access. *Br Dent J*. 2013; 214(8):379.
 13. General Dental Council. "Preparing for practice-dental team learning outcomes for registration." London: General Dental Council, 2011.
 14. Verhoeven BH, Van der Steeg AFW, Scherpbier AJJA, Muijtjens AMM, Verwijnen GM, van der Vleuten CPM. Reliability and credibility of an Angoff standard setting procedure in progress testing using recent graduates as judges. *Med Educ* 1999; 33:832–7.
 15. Cizek, G. J., & Bunch, M. B. Standard setting: A guide to establishing and evaluating performance standards on tests. London: Sage, 2007.
 16. R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at <http://www.R-project.org/> (Accessed May 2017).
 17. McAlpine M. A Summary of Methods of Item Analysis. 2002. CAA Bluepaper Number 2. CAA Centre, Glasgow. ISBN 1-904020-02-X

18. van der Vleuten CP, Schuwirth LW, Muijtjens AM, Thoben AJ, Cohen-Schotanus J, van Boven CP. Cross institutional collaboration in assessment: a case on progress testing. *Med Teach*. 2004; 26(8):719-25.
19. Freeman A, Van der Vleuten C, Nouns Z, Ricketts C. Progress testing internationally. *Med Teach*. 2010; 32:451–5.
20. McHarg J, Bradley P, Chambelain S, Ricketts C, Searle J, McLachlan J. Assessment of progress tests. *Med Educ*. 2005; 39:221–7.
21. Muijtjens AMM, van Mameren H, Hoogenboom RJI, Evers JLH, van der Vleuten CPM. The effect of a don't know' option on test scores: number-right and formula scoring compared. *Med Educ* 1999; 33:267–75.
22. Coombes L, Ricketts C, Freeman A, Stratford J. Beyond assessment: feedback for individuals and institutions based on the progress test. *Med Teach*. 2010; 32(6):486-90.
23. Chichester SR, Wilder RS, Mann GB, Neal E. Incorporation of evidence-based principles in baccalaureate and nonbaccalaureate degree dental hygiene programs. *J Dent Hyg*. 2002 Winter;76(1):60-6.
24. Battrell A, Lynch A, Steinbach P, Bessner S, Snyder J, Majeski J. Advancing education in dental hygiene. *J Evid Based Dent Pract*. 2014 Jun;14 Suppl:209-21.
25. Furgeson D, Kinney JS, Gwozdek AE, Wilder R, Inglehart MR. Interprofessional Education in U.S. Dental Hygiene Programs: A National Survey. *J Dent Educ*. 2015 Nov;79(11):1286-94.
26. Gadbury-Amyot CC, Bray KK, Austin KJ. Fifteen years of portfolio assessment of dental hygiene student competency: lessons learned. *J Dent Hyg*. 2014 Oct;88(5):267-74.

Appendix I Criteria for Applied Dental Therapy Knowledge Test Grade Boundaries

Grade	Criteria
Excellent	Score is greater than or equal to the standard +1 standard error of measurement and is equal to or greater than 1 standard deviation above the mean
Satisfactory	Score is greater than or equal to the standard +1 standard error of measurement, but less than the mean +1 standard deviation
Borderline	Score is greater than or equal to the standard -1 standard error of measurement, but less than the standard +1 standard error of measurement.
Unsatisfactory	Score is less than the standard – 1 standard error of measurement.