2019-06-28

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10.1111/eje.12451
European Journal of Dental Education
Wiley

Effect of Constant *versus* Variable Small-Group Facilitators on Student Basic Science Knowledge in an Enquiry-Based Dental Curriculum

Running title: EBL facilitators and basic science knowledge

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Key words: Enquiry-based learning, facilitators, basic dental science

Abstract

Introduction: The role of small-group facilitators is of pivotal importance for the success of curricula based on active learning. Disorganised tutorial processes and superficial study of the problem have been identified as main hindering factors for students' learning. The aim of this study was to evaluate the influence of consistency of facilitation on students' performance in knowledge-based, basic science assessments in a hybrid, enquiry-based (EBL) undergraduate dental curriculum.

Materials and Methods: This was a retrospective study of 519 year one and year two undergraduate dental students, enrolled at Peninsula Dental School between 2013 and 2018. Twice in each academic year, students sat a 60-item single-best-answer, multiple-choice examination. Percentage and Z-scores were compared between students whose EBL groups had the same facilitator throughout the academic year, and those whose EBL group was facilitated by different members of staff. All EBL facilitators were dentally qualified but with different levels of expertise in basic dental sciences, prior EBL facilitation, involvement in the curriculum design and university affiliation.

Results: No statistically significant difference was observed in the percentage or Z-scores of students whose EBL sessions were supported by consistent or variable facilitators in any of the 18 MCQ tests. Z-scores of year 1 students were more variable than for year 2 students. In addition, pairwise comparisons revealed no statistically significant differences in student Z-scores between any of the permanent facilitators' groups.

Conclusions: The results of our study may influence the design and delivery of enquiry-based curricula as well as human resources management by shifting the

focus from maintaining facilitator consistency to ensuring comparable training and approaches across facilitators.

Introduction

Dental curricula need to meet the changing needs of dental professionals and provide new, robust and challenging learning experiences for dental students. Various metrics have been used for analysing teaching excellence, and dental education providers are increasingly interested in curriculum design and processes that underpin and enhance students' engagement with learning (1).

The term enquiry-based learning (EBL), which also accommodates the more widely known "problem-based learning" (PBL) philosophy, is a learning methodology that places emphasis on the holistic development and knowledge of the students. Enquiry-based learning and problem-based learning fall under the wider umbrella of "active learning" and appear to be used interchangeably in the literature (2). For the purposes of this paper, the term "active learning" will be used to encompass both of these teaching and learning approaches. They are based on the premise that learning occurs as a result of interactions between peers, staff and in the case of dentistry, patients. Its starting point is a clinical case that allows learners to identify the requirements for better understanding of the clinical situation, applying principles that encourage long-term memory and deep knowledge acquisition, integrating learning objectives related to different elements of the curriculum (3).

The essential elements of active learning curricula are small-group discussion sessions and self-directed, student-centred learning. At our institution, seven to nine students collaborate in a group, facilitated by a dental professional, to jointly identify different topics, examine existing knowledge, formulate learning objectives and test the application of newly acquired knowledge. Students are expected to derive their own learning outcomes and are encouraged to work collaboratively throughout the case and regard each other and the facilitator as

respected equals (4). Active participation in learning is more beneficial to students than passive transfer of information, it encourages collaboration, promotes the connection of ideas and concepts, and facilitates retention and recall of information (5). In addition, during each case there are plenary lectures, workshops and life science sessions which are always in a context relating to the case and are intended to both broaden and focus student knowledge and attitudes. This blend of PBL, situated learning and enquiry-driven, “every day” learning stands at the heart of the Peninsula Dental School’s enquiry-based learning ethos.

The contact time between EBL facilitators and students is much higher than between teachers and students in conventional lectures. The EBL educator is a facilitator of student learning, whose role is demanding and much more exposed than that of the traditional teacher. The extreme open-endedness of the EBL facilitator's role usually expands the limits of the educator's remit and knowledge, even beyond those typical of problem-based learning. EBL facilitators not only need to understand and appreciate the behaviours required, they also need to have the confidence that they are competent to perform these roles (6). Therefore, introduction of EBL into a curriculum requires an implementation plan with regard to the training of facilitators and the distribution of human resources.

There is limited published work on the role and effectiveness of EBL facilitators on student achievements, in contrast to an abundance of literature specifying what the role of the facilitator in PBL should be.

Student learning and the finer details of the implementation of active learning pedagogy into integrated curricula depend on the facilitator’s understanding and appreciation of their responsibilities. Facilitators are not supposed to

provide content information but to encourage student participation, ask probing questions, mentor and assess students and be a role model (7). Facilitator performance might be influenced by several factors, including: student prior knowledge, group composition and productivity, cultural and gender differences, problem design, level of expertise, department affiliation and familiarity with the EBL process (8).

The style of small-group facilitation directly affects the group work. Active facilitation encompasses orientation and explanation, defining learning objectives, intervening with intra-group processes, encouragement of participation and providing corrective feedback, while less facilitative tutors tend to delegate roles, are not aware of defined learning objectives, don't intervene with intra-group processes and do not provide feedback during discussion sessions (9). Nevertheless, evidence on the influence of facilitator performance and style on the extent of students learning and development is scarce and inconclusive. Some studies suggest that the student learning experience and performance depend on facilitator's skills (10). Others have shown that students' performance in a clinical course is independent of facilitators' expertise or experience (11). Interestingly, facilitators' perception and grades of students' knowledge do not correlate with student performance in written exams (12).

The aim of this study was to evaluate the importance of consistency of facilitation style on students' performance in knowledge-based, basic science assessment of year one and two students participating in a hybrid, patient-centred, enquiry-based undergraduate dental curriculum.

Materials and Methods

Ethical approval

The study was approved by the Faculty of Health and Human Sciences and Peninsula Schools of Medicine and Dentistry, University of Plymouth Research Ethics Committee (17/18-839).

Study population and curriculum

This paper describes a retrospective study of 519 year one and year two undergraduate dental students (5-year curriculum), enrolled at Peninsula Dental School between 2013 and 2018. Students were randomly assigned to one of eight to ten EBL groups in each academic year, each consisting of seven to nine students. One facilitator, of which there were twelve between 2013 and 2018, was randomly assigned to EBL groups. Each EBL facilitator supported two EBL groups each academic year. In each year, due to circumstances beyond the schools control such as long-term illness, staff turnover, and maternity leave, there were two to four EBL groups that did not have a permanent, consistent facilitator. This provided our two groups for comparison: students whose EBL groups had the same facilitator throughout the academic year, and those whose EBL group was facilitated by different members of staff over the course of the academic year. Numbers of students in each group in each academic year are shown in Table 1.

EBL facilitators were all dentally qualified but with different levels of expertise in basic dental sciences, prior EBL facilitation, involvement in the curriculum design and assessment, and university affiliation. They all attended a full day training on enquiry-based learning methodology before the start of each academic year and observed a session with an experienced EBL facilitator. In

addition, case-review meetings were organised with respective year leads before the start of each case, to clarify learning objectives.

Patient-centred case scenarios, written to promote problem-solving and each lasting for two weeks, were used for student-led, enquiry-based sessions (four sessions per case). Student learning was guided by a series of plenary lectures and life science sessions, delivered in the context of clinical scenarios.

Integrated dental science examinations

Twice in each academic year, students in both years of study sat a 60-item single-best-answer, multiple-choice examination assessing basic dental science knowledge. For each examination, students sit a paper comprising a different 60 items. Each paper is standard set using a combined Angoff-Hofstee method. Correct responses received a score of 1, blank or don't know responses received a score of 0, incorrect responses received a score of -0.25. For each student, their scores across both tests sat in a given academic year have been averaged to provide a mean percentage score for basic dental science knowledge.

Statistical analyses

In order to compare the effects of facilitator type (constant, variable) on student performance, average percentage scores were subject to analyses of variance with facilitator type and year as between-groups independent variables. These analyses were conducted separately for years one and two, then including demographic variables (gender, ethnicity, and disability) in order to assess the influence of these factors, and finally converting individual test scores to Z-scores to control for variation in test difficulty across tests and academic years.

Differences in student Z-scores between facilitators (constant assessors treated as separate groups, and a 'variable' group pooling students who had variable

assessors) were assessed using pairwise t-tests, with alpha adjusted for multiple comparisons using a Bonferroni correction.

Results

Descriptive statistics for number of students, mean MCQ percentages and Z-scores by year of study, academic year and facilitator type are shown in Table 1.

Table 1: Descriptive statistics for number of students, mean MCQ percentages and Z-Scores by academic year, year of study and facilitator type.

			Number of students	Percentage Score		Z-Score	
Stage	**Academic Year**	**Facilitator Type**	**N**	**Mean**	**SD**	**Mean**	**SD**
1	1314	Constant	46	71.23	10.24	0.07	0.91
1	1314	Variable	16	67.23	10.21	-0.28	0.91
1	1415	Constant	43	66.19	11.07	0.33	0.78
1	1415	Variable	14	60.00	8.25	-0.10	0.57
1	1516	Constant	41	64.07	7.66	0.37	0.58
1	1516	Variable	14	62.94	6.50	0.28	0.50
1	1617	Constant	46	63.69	10.92	0.11	0.77
1	1617	Variable	12	70.60	6.37	0.59	0.45
1	1718	Constant	37	59.53	10.88	0.04	0.88
1	1718	Variable	22	59.97	13.34	0.07	1.07
2	1415	Constant	48	61.14	10.55	0.04	0.95
2	1415	Variable	12	59.62	8.19	-0.08	0.72
2	1516	Constant	28	64.03	11.17	0.05	0.99
2	1516	Variable	26	62.89	9.53	-0.05	0.84
2	1617	Constant	41	67.88	7.46	0.04	0.90
2	1617	Variable	15	67.05	7.99	-0.07	0.96
2	1718	Constant	29	58.46	10.43	-0.15	0.90
2	1718	Variable	29	62.04	10.53	0.16	0.91

Individual scores of Year 1 and Year 2 students who were facilitated by permanent and variable EBL facilitators were compared for each academic year and for both tests (Figure 1).

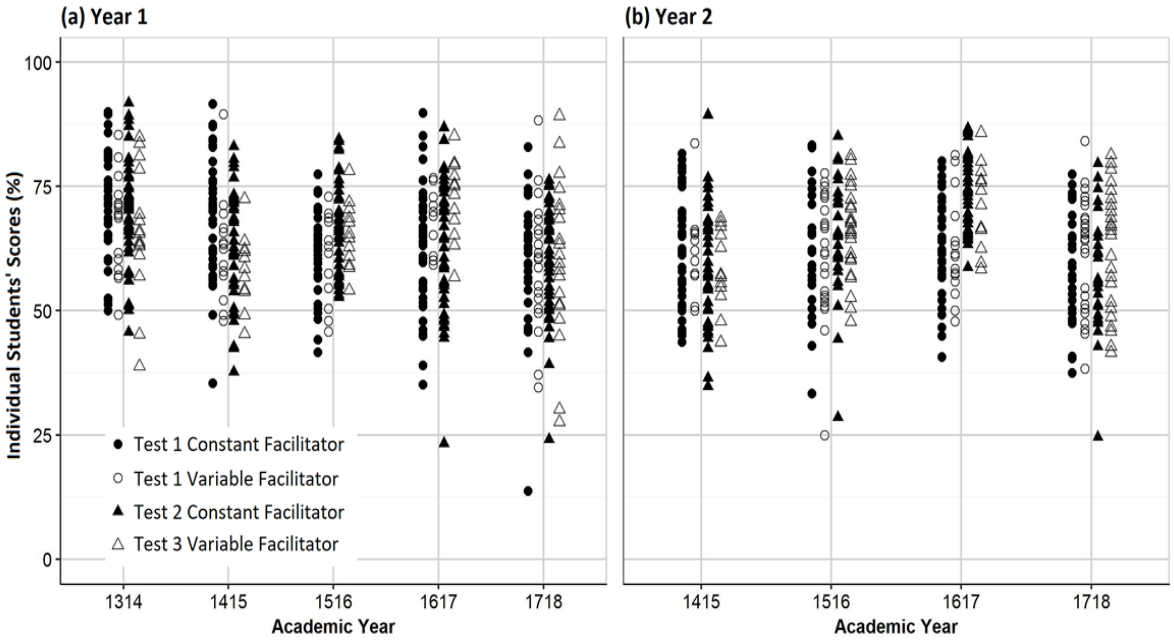

Figure 1: Individual scores (%) of year 1 (a) and year 2 (b) dental students who were facilitated by a permanent and variable EBL facilitators across 18 MCQ tests and 5 academic years.

No statistically significant difference was observed in the scores of students whose EBL sessions were supported by permanent or variable facilitators in any of the 18 MCQ tests.

Comparison of average percentage scores of all year 1 and year 2 dental students in a particular academic year (during the 5 year monitoring period) by two facilitator types (Constant, Variable) revealed no main effect of facilitator type, or interaction between facilitator type and academic year (Figure 2a). There was, however, a main effect of academic year; Year 1 $F(4,281)=7.361$, $p<0.001$, Year2 $F(3,220)=0.6.843$, $p<0.001$ (student performance varied across years).

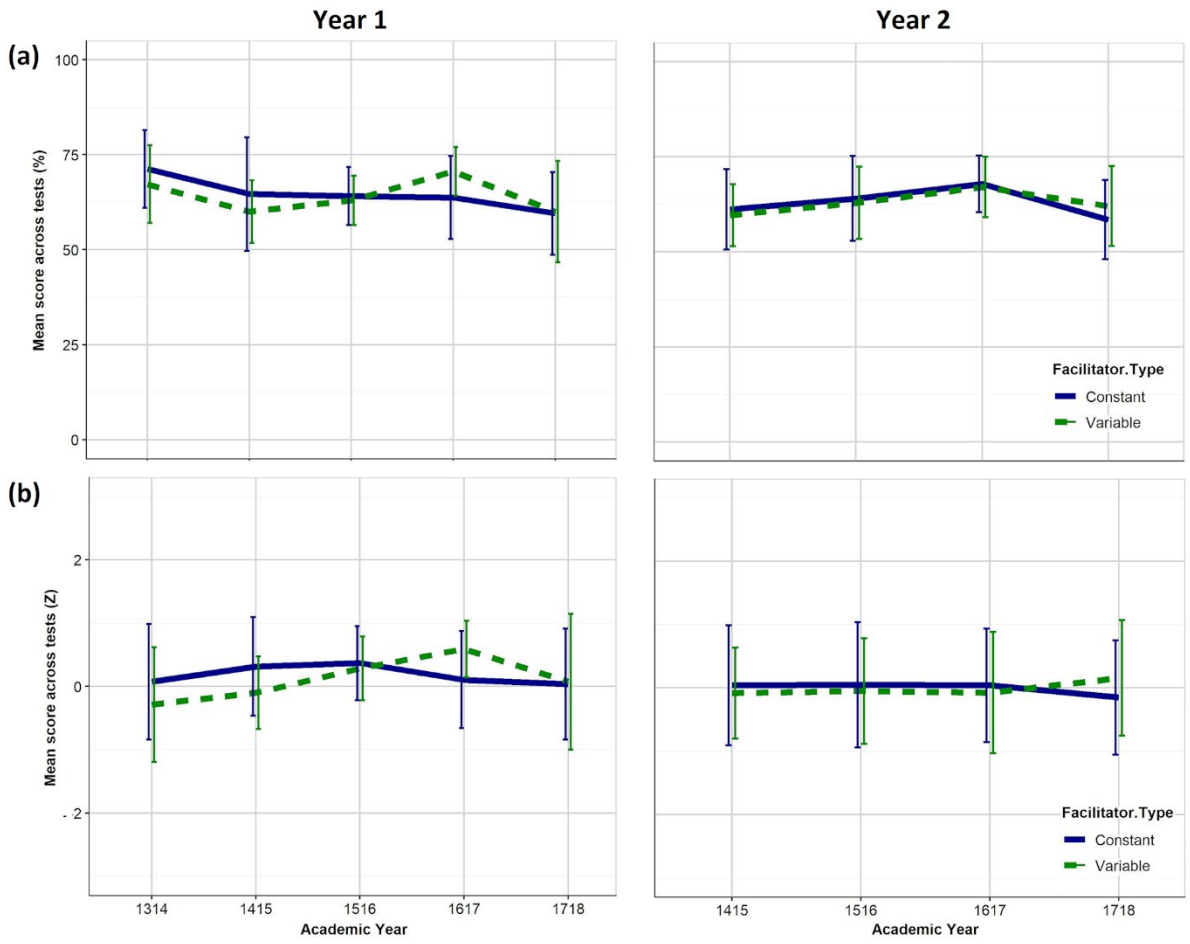

Figure 2: Percentage scores (a) and Z-scores (b) by facilitator type and academic year for Year 1 and Year 2 students. Error bars show +/-1SD.

When considering Z-scores, no effects of academic year or facilitator type were found, although Z-scores of year 1 students were more variable than for year 2 students (Figure 2b). Year 1 students who were facilitated by variable tutors sometimes performed worse and sometimes better than students who were facilitated by a permanent tutor, while for year 2 students the Z-scores were more consistent between the two groups. These effects remained the same when controlling for gender, ethnicity and disability.

Distributions of Z-scores for all Year 1 and Year 2 dental students across the five academic years facilitated by each of the eight permanent EBL facilitators (A-H)

and a group of students who had variable facilitators (Variable) are shown in Figure 3. Pairwise comparisons revealed no statistically significant differences in scores between any of these groups.

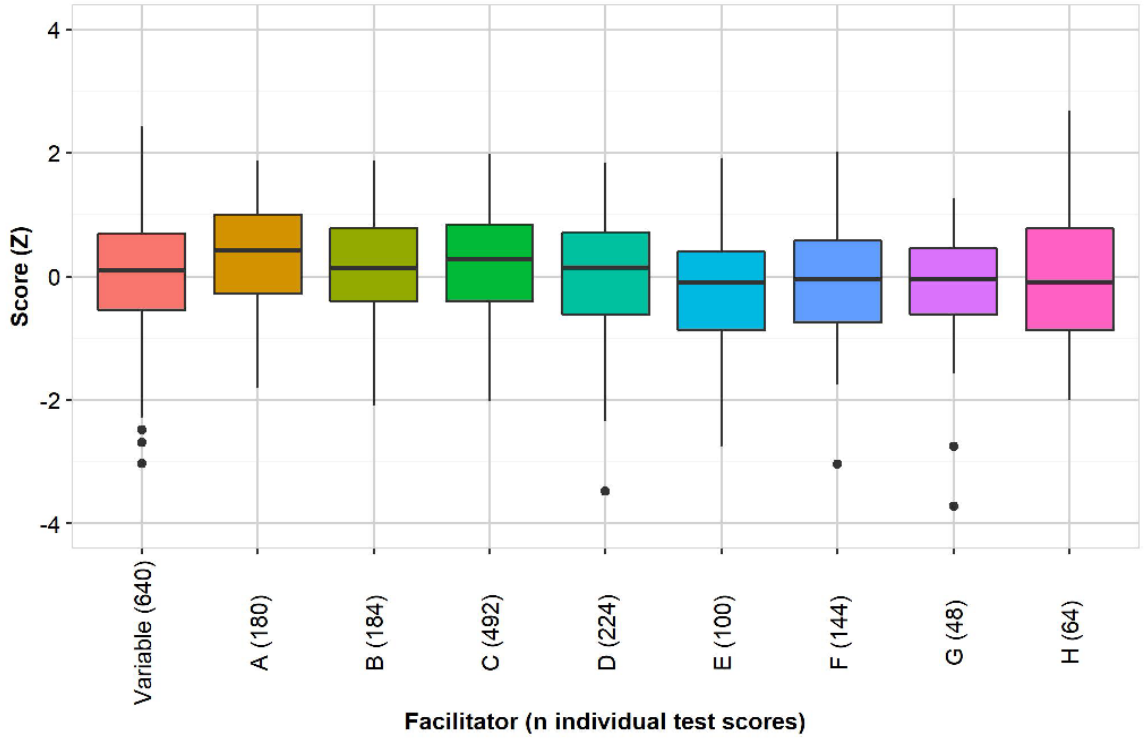

Figure 3: Distributions of Z-scores of all Year 1 and Year 2 dental students across five academic years, by facilitator (A-H: constant facilitators; Variable: pooled Z-scores for all students who were in EBL groups with variable facilitators).

Discussion

Educating healthcare professionals is becoming increasingly challenging in the face of rapid scientific, pedagogic, and technological progression. Developing dental curricula fit for purpose, capable of producing responsive, flexible, and open to new possibilities oral healthcare professionals requires time, attention, and professional development. Active learning, which promotes digital and research literacy, the shift from competencies to capabilities, patient-centred

care, connectivism, transparency and self-directed learning is in no way a panacea for dental education providers but is a promising way of creating “the classroom of the future” (13).

In its generic form, active learning includes a facilitator (tutor) and students working side by side, in collegial pedagogy (14). Successful small-group learning relies on functional group processes. These conglomerates need to be together long enough to allow for beneficial, effective group dynamics to develop but sometimes need to be changed due to personality clashes, dysfunctional behaviour, staff turnover or other unforeseen circumstances (15). Active learning courses are resource-intensive and recruitment, retention, and motivation of staff members to remain engaged in academia is becoming problematic (16), particularly where those staff are clinical subjects and domain experts contributing outside the demands of their regular employment.

Given the amount of contact time our students spend with their EBL facilitators (3 hours per week), we examined the influence of permanency and consistency of the EBL facilitators on student outcomes by comparing scores from basic science MCQ tests taken by first and second year students in EBL groups, facilitated by permanent and variable facilitators. No statistically significant differences were observed between these two groups of students over five academic years and 18 MCQ tests. The variations between differently facilitated groups were more pronounced for Year 1 than for Year 2 students. This may be due to the novelty of EBL to Year 1 students and the uncertainty it comes with, compared to their conventional secondary and further education. It has been suggested that more facilitative styles of tutoring may be better suited to early stages of PBL curricula while the non-facilitative tutoring styles should be

introduced when students have gained sufficient knowledge of the active learning pedagogy (9).

While there is general consensus that training facilitators is critical for the success of active learning, there is debate about the optimal background of tutors. Small group facilitators have an important role of modelling desired student behaviour, focussing student effort on deep and critical thinking and raising student awareness and meta-cognitive ability (17). It has also been shown that individual students working on their own are unlikely to come to the same level of scientific concepts that a cooperative learning group would. The unfolding social dialogs in the groups, including confirmatory and challenging statements made by individual members in a given group, leads to shifts in student understanding (18).Crucial to an effective EBL process is robust content and effective facilitation of the enquiry process, as well as the social interaction of the group. Effective facilitation needs to be flexible and enabling, but this can be challenging for tutors and students alike. Some students appear to find the EBL process stressful and are reassured by the inclusion of more traditional methods offered through expert lectures (19). Students that belong to a community of enquiry also have the opportunity of assuming the role of a teacher (20). It is, therefore, important to examine whether facilitator-student interactions can be more or less important than student-student interaction for students' learning in EBL environments. Disorganised or haphazard tutorial processes and superficial study of the problem have been identified as main hindering factors for students' learning in small-group sessions (21). In our study, all Year 1 and Year 2 EBL facilitators have undergone the same training but their content expertise, EBL experience, and faculty affiliations were diverse. Our findings are in agreement with previous studies that have found no influence of small group facilitator's subject-matter expertise and their ability to

explain concepts on students' learning outcomes (22), but are novel in the way that the Z scores of all students facilitated by variable EBL facilitators were in the same range as those of students taught by permanent EBL facilitators.

Conclusions

The results of our study may influence the design and delivery of enquiry-based curricula as well as human resources management by shifting the focus from maintaining facilitator consistency to ensuring comparable training and approaches across facilitators. Further qualitative and quantitative studies are needed to explore the impact of facilitator consistency in small-group tutoring on students' satisfaction, implicit learning, their perceptions of the hidden curriculum and achievements in specific learning outcomes.

Acknowledgements: We would like to thank all our EBL facilitators for their commitment and dedication to instilling the values of deep learning skills in our students.

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