

Dental students' ability to judge the quality of composite restorations' exemplars depicted in photographs and their impact on preclinical skills

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Abstract

Introduction: Assessing exemplars as a formative activity is thought to promote students' learning. This study aimed to investigate dental students' ability to judge the quality of composite restorations' exemplars depicted in photographs and their impact on students' preclinical skills.

Materials and Methods: In a non-randomised controlled crossover trial with two intervention arms, 92 undergraduates in their first preclinical course self-enrolled in into the intervention group (A1-INT) or control group (B1-CT). The intervention group assessed photographic images of composite restorations before restoring an ivory premolar with composite while the control group restored the same tooth without assessing the photographic exemplars. Intervention and control groups were swapped 3 days later in a second iteration (B2-INT, A2-CT). Data were analysed in SPSS® version 27 using nonparametric tests.

Results: Students who did not complete all activities in the study were excluded. Therefore, 57 out of the 92 student participants were included in the study analysis. No significant differences were observed between intervention and control groups' ability to assess quality of photographic exemplars or restoring a tooth in both iterations.

Conclusion: Students were able to identify the quality of composite restorations in photographic exemplars. It appears that assessing photographic exemplars did not have an immediate impact on students' ability to restore a tooth with composite.

KEYWORDS

exemplars, feedback, judgement, learning, MS forms, preclinical

1 | INTRODUCTION

Exemplars of academic work illustrating different levels of quality have been proposed to promote students' self-regulation^{1,2} resulting in more effective learning.³ Within the social cognitive theory, the role of exemplars in self-regulated learning develops in four stages: Observation, emulation, self-control and self-regulation.⁴ In this

process, students first identify the salient aspects of the exemplar without performing. Then students emulate the exemplar internalising it.⁵ Third, a new task is performed applying the emulated ideas. Finally, learners self-regulate by adapting their skills to a different context.⁶

Exemplars have been classified in two types: Exemplars of a process and exemplars of outcomes.⁷ In a dental preclinical context, for

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instance, an exemplar of a process would be a video demonstrating the restoration of a tooth, or several demonstrations of different proficiency. Exemplars of outcomes would be completed restorations. This study focuses on exemplars of outcomes and the first stages of self-regulated learning: Observation and emulation.

The current literature indicates that assessing exemplars of academic work promotes students' learning efficacy^{2,8} by promoting students' understanding of the intended learning outcomes.⁹⁻¹² Importantly, exemplars illustrate criteria and standards students would find difficult to understand with explanations only.^{12,13}

Handley and Williams (2011) reported that students become vicarious learners when provided the opportunity to observe exemplars from previous cohorts that show marking criteria and teachers feedback.¹⁴ Assessing exemplars gives a point of reference for meaningful feedback¹⁰ because students can experience and understand how teachers use criteria and determine standards before students' work is assessed.^{1,15}

Exemplars enhance learning provided students actively participate in their appraisal. Dialogue between students and teachers around exemplars not only encourages active learning but also helps students understand and teachers explain tacit concepts of quality that can be learnt with practice only.^{12,16,17} Furthermore, a student who visualises and understands quality would be more likely to articulate questions and engage in conversations on how to achieve the required standard of quality.⁷ It has been reported that students' most valued aspect of assessing exemplars are teachers' explanations.¹² But relying on detailed explanations can encourage students' passive learning and even discourage dialogue between students and their instructors.¹⁴ Passively listening or reading teachers explanations may not improve students understanding,¹⁸ and it can result in misinterpretation of the exemplar.¹⁴

Passively observing is not enough to enhance learning. Exemplars enhance learning by developing students evaluative judgement abilities¹⁹ and this is possible when students have the knowledge to discern quality^{5,14} and opportunities to actively evaluate exemplars.^{9,20,21}

Exemplars are used extensively in preclinical dental education but research on their use is scarce. The limited available literature seems to indicate that exemplars could facilitate understanding of the marking process,^{9,20,21} enhance feedback^{22,23} and promote dialogue between students and teachers.^{24,25} Conversely, student self-assessment is one of the most frequently reported formative activities used in preclinical dentistry.²⁶ However, judging the quality of one's work can be problematic because of students' and teachers' unconscious bias in the appraisal process.²³ Students may be more open to discuss defects found in an exemplar than defects found in their own work. Hence, assessing the quality of exemplars can be a good first step for students to identify quality without the bias involved in self-assessment.

A useful medium to show the quality of dental restorations is digital photography.^{27,28} Digital photographs are simple to obtain and to embed in applications and/or learning management systems

facilitating access. Rung et al. (2021) recently reported that exemplars help dental students understand dental procedures and their expected quality⁷ even when many of the exemplars favoured by students are not curated by teachers. Students access to a wide variety of dental procedures, videos and photographs, available on the internet. It is unknown, however, if students can judge the quality of exemplars depicted electronically.

Therefore, the aims of this study are to investigate students' ability to effectively evaluate exemplars of composite restorations depicted in photographs and whether this has an impact on students' ability to restore a tooth with composite and self-assess it.

2 | MATERIALS AND METHODS

2.1 | Study design and context

This non-randomised controlled crossover trial explored the use of photographic exemplars of compound composite restorations in a cohort of second-year students attending the preclinical simulation facilities. Students in this course, self-enrolled in a morning or afternoon preclinical sessions. They attended two weekly simulation preclinical sessions of 2h 45min duration as part of their enrolment. In this preclinical course, each student was provided a dental unit with a phantom head and a computer.

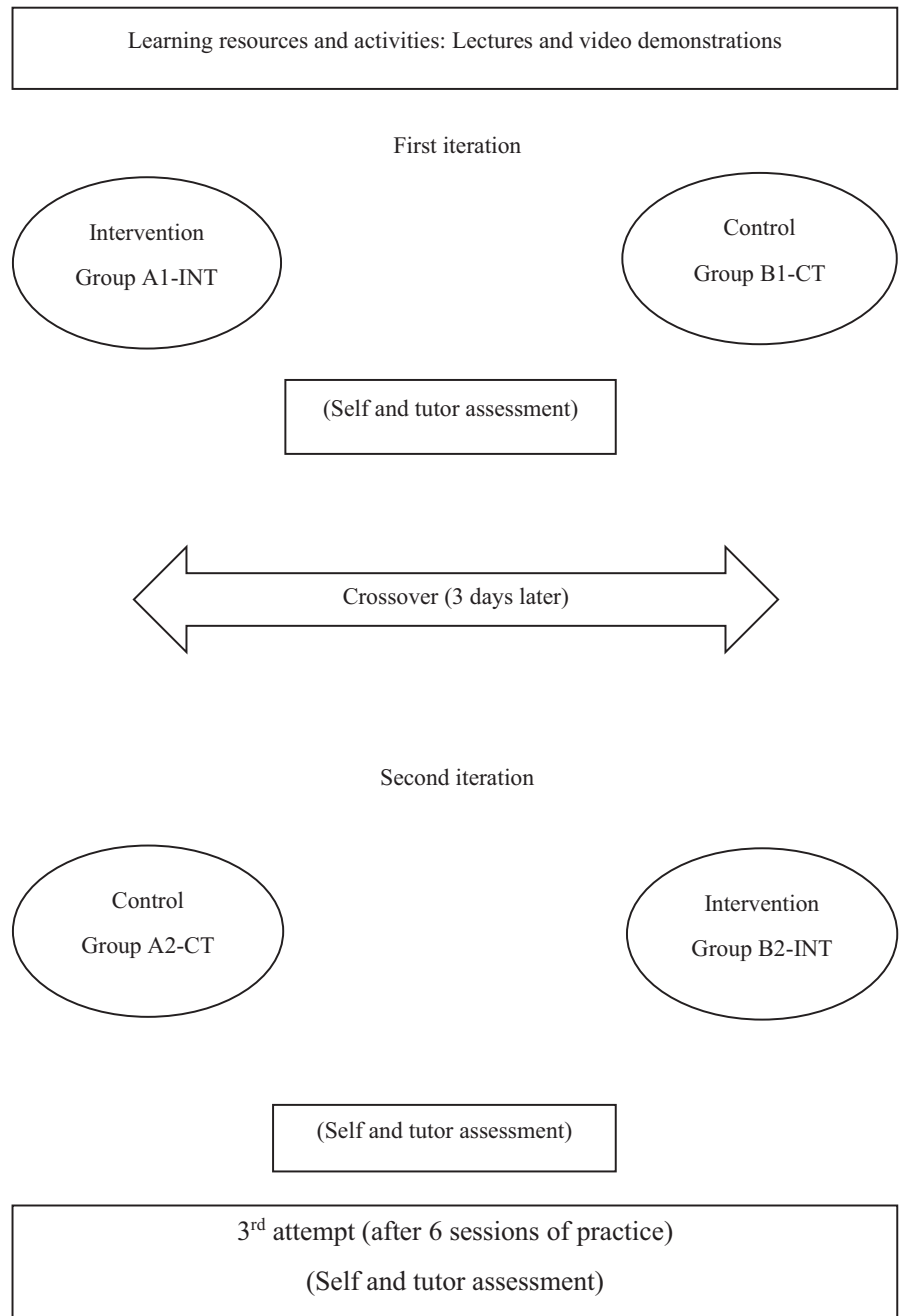
In the first iteration, all students enrolled into the morning session were assigned into the intervention group (A1-INT) and those in the afternoon were assigned into the control group (B1-CT). The intervention group assessed photographic images of composite restorations before restoring an ivorine premolar with composite while the control group restored an ivorine tooth without assessing the photographic exemplar. Intervention and control (B2-INT and A2-CT) were crossed over for the second iteration 3 days later (Figure 1).

2.1.1 | First iteration (Intervention group)

Students in the intervention group assessed three photographic exemplars (E) of composite restorations. Students followed a rubric with four criteria. For each criterion' score, students provided (a) rationale for their judgement and (b) suggestions on how to improve the criterion. In addition, a final judgement on the overall clinical suitability of the restoration was given by the students. Students had 30min to complete this task. Photographs of exemplars were embedded, and comments written on purposely created Microsoft™ (MS, USA) Forms (Appendix S1).

After assessing exemplars, students restored a premolar with a standard mesio-occlusal preparation (Nissin Catalogue code UL 54B) and then self-assessed the restoration. Students had 1 hour for the restoration and 15min for assessment. Self-assessment scores and comments were recorded in Microsoft™ (MS, USA) Forms designed for the purpose. (Appendix S2).

FIGURE 1 Non-randomised controlled crossover trial.



2.1.2 | First iteration (Control group)

Students in the control group performed the same activities as the intervention group without assessing the photographic exemplars of the composite restoration.

2.1.3 | Second iteration (Intervention and control group)

Three days later, the control and intervention groups were crossed, and the students repeated the previously described activities.

2.1.4 | Students' performance after nine sessions of practice

After nine sessions of preclinical practice, students restored a molar with a standard mesio-occlusal preparation (Nissin Catalogue code UR 64) and then self-assessed it under the same conditions of first and second iteration.

2.2 | Participant and procedures

Participants were students enrolled in the first preclinical course of the dental programme. The theory component of the course:

Lectures, readings and demonstrations were delivered online. The first iteration was students' first attempt in restoring a tooth with composite. All activities in this study were formative and did not count towards students' grades. The study was approved by the institution ethics' committee Ref no 2019/455.

2.2.1 | Appraisal method

Quality of restorations were decided using rubrics modified and simplified from the Rye/USPHS Clinical Criteria²⁷ (Table 1).

2.2.2 | Selection of exemplars

Three exemplars (E1, E2 and E3) of mesio-occlusal upper first molars restored with composite were curated by four instructors and one of the authors from a pool of 102 restored teeth. E1: each criterion was 'acceptable', E2: each criterion was 'standards not met' and E3: each was 'ideal'.

2.2.3 | Photographic method

Standardised photographs were taken of each restoration with a Canon™ 600D (Canon Inc. Japan), 1/160s. f/5.6, ISO 125. Digital photographs were set in .JPEG 10 Mega Pixels at 50% compression, 32 bits colour depth, resolution 72 dpi, CMYK. Two photographs per exemplars were taken, occlusal and buccal. The photographs were uploaded to Microsoft™ Forms™ (Microsoft Inc., USA). One form per exemplar was used (Appendix S1).

2.2.4 | Tutors' appraisal of students' restorations

In each iteration, and using the same rubric as students, four tutors with minimum 2-year experience supervising students and assessing preclinical work were required to randomly assess equal

number of students restorations. They also provided a rationale for their judgement and how the restoration could have been improved if necessary. The identity of the students was unknown to the tutors.

Tutors' scores and comments were recorded in MS Forms and then a report was individually sent to each student using Excel™ and Outlook™ email merge on the following day (Appendix S3). All tutors in the study participated in marking calibration activities and demonstrated acceptable to high level of agreement.

2.2.5 | Tutors marking calibration

Tutors followed the school protocol for calibration and moderation. To assess the level of interrater agreement, seven tutors assessed the same composite restorations individually. Agreement between tutors was calculated using agreement test Somer's *D* and Spearman correlation analysis. All pairs show strong agreement (Mean 0.81 Correlation), with the lowest correlation at 0.69 and the highest at 1.00 suggesting the acceptable to high level of interrater agreement.

2.3 | Data collection

All data were recorded and collected in Microsoft™ (MS, USA) Forms, the link to Forms was hosted in MS Onenote™. Students completed the tasks individually using their work' unit computer (Dell Inc., USA) display 1920×1080. Data from MS Forms was then collected and collated in MS Excel™.

2.4 | Data analysis

A Chi square test was used to determine differences between groups A1-INT, first iteration and group B2-INT second iteration of the crossover. A Wilcoxon sign rank test for categorical variables was used to determine all students' agreement with a predetermined exemplars' scores.

TABLE 1 Marking criteria for two surfaces composite restoration.

Criteria	Ideal	Acceptable	Standards not met
Anatomy	Accurate reproduction of tooth anatomy features cusp, pits and grooves	Vague reproduction of tooth anatomy features	Incorrect/lack anatomy features and or change in anatomy due overuse of polishing burs
Margins	Continuity between composite and tooth	Margins slightly over/under-filled	Gross under/over extension
Point of Contact	Accurate reproduction of B, L, O and G embrasures. Resistance to flossing	One embrasure not present. Slight resistance to flossing	More than one embrasure not present and/ or no resistance to flossing
Finishing	Smooth and glossy surface. There are not scratches or voids	Smooth surface but with some scratches and small voids	Rough surface and/all multiple scratches and voids

The rationale for the score students awarded to exemplars and suggestions on how the restoration could have been improved was analysed in 2 cycles. First, an Excel™ spread sheet organised students' comments about each exemplar by criterion and grouped by comments of those who agreed with the exemplar and those who disagreed with the exemplar predetermined scores. A deductive method was used since comments of students were already organised by themes, that is Anatomy, Margins, Point of contact and Finishing. A word cloud generator was used to find the frequency of words and identify emerging key ideas mentioned within each of the themes. In the second cycle of the analysis, key aspects mentioned by students were grouped and summarised by criterion and score. A descriptive narrative presents and analyses the findings.²⁹

Further quantitative analysis using Chi square compared tutors' scores and students' self-awarded scores in first, second iteration and third attempt. Data were analysed in SPSS® version 27 using non-parametric tests.

3 | RESULTS

Thirty-seven participating students were excluded from the study as they missed at least one of the pre-established activities in this study. Therefore, 57 students out of 92 were included in the data analysis.

3.1 | Student ability to judge the quality of photographic exemplars of composite restoration

3.1.1 | Scores awarded to photographic exemplars by Group A1-INT vs Group B2-INT

There were no statistically significant differences between scores awarded by intervention groups in first and second iteration (Table 2).

3.1.2 | Students' awarded scores vs. predetermined scores

Students tended to agree with predetermined scores when the exemplars were in the extremes (ideal and standards not met). The exceptions were 'Point of contact' with the standard not met predetermined score (E2), and 'Finishing' with the ideal predetermined score (E3). Students tended to downgrade the acceptable exemplar particularly the 'Point of contact' (E1) (Table 3). As per the restoration clinical suitability, students mostly agreed with the predetermined score in E2 (Standards not met), and E3 (Ideal) while most students disagreed with predetermined scores for E1 (Acceptable) (Figure 2).

3.2 | Students' justifications of scores awarded to the exemplars and suggestions for the restoration's improvements: Analysis of students' rationale of the scores

Students' comments provided an insight into what they could see, or not, in exemplars depicted in photographs. The key findings from students' comments were organised by Anatomy, Margin, Point of Contact, Finishing and Clinical suitability of the restoration.

Students justified Anatomy not meeting the standards noting the lack of definition of features such grooves and pits. When anatomy was scored as Acceptable, students mentioned the visible features that could be better defined. In both cases, students suggested strategies involving the sculpting the missing features.

'Cusps are not defined well as their extension to the restoration doesn't follow the remaining tooth surface extensions. Central fissure is shifted buccally. buccal and lingual fissures are not defined clearly.' Suggesting *'create cusps, fissures and pits by removing excess material with flat plastic instrument following the tooth surfaces remaining before cure'*.

Students concurred that the problem with the margins in the 'Standards not met' exemplar was excess of material and the solution was to remove excess before curing the composite. On the other hand, when margins were 'acceptable' the rationale varied: *'Slight EXCESS on the LINGUAL but can be removed through polishing'*. Others saw the opposite such: *'LOOKS like it could be underfilled on LINGUAL'*. The discrepancy between two students looking at the same picture can be explained by a student comment *'it is hard to see in a photo, the margins could be ideal, I would need to check with a probe'*.

Students' rationale for point of contact less than ideal suggests they clearly understand an optimal point of contact requires accurate embrasures. Students' comments on how this aspect of the restoration could have been improved vary from the succinct: *'Yes. Contour the MARGINAL RIDGE before curing'* to a more elaborated response such: *'Ensuring that you remove excess composite from the MARGINAL RIDGE area before curing it. If the restoration has been cured, you would use a football bur (for example), to reduce the height of the MARGINAL RIDGE. You could then use the discs to create an OCCLUSAL embrasure, and also ensure the lingual/buccal embrasures are not overfilled'*.

Assessing the point of contact appears problematic. The photographic exemplar 'standard not met' clearly shows there is a gap between the restoration and the adjacent tooth in the occlusal view. However, the gap is not apparent in the photograph showing the same exemplar's buccal aspect. Few students mentioned the absence of any contact and only one student elaborated on the discrepancy between the occlusal and buccal views in the pictures. *'From the above picture it appears as if the contact is not a point but rather a whole region going down the proximal aspects of the tooth while from previous pictures there appeared to be no contact - either way, unacceptable'*. Suggestions on how this aspect of the restoration could have been improved involves better adaptation and selection of the matrix system *'Yes, accurate*

	Criteria	A1-INT (n=25) n (%)	B2 INT (n=30) n (%)	χ^2	p
Exemplar 1					
Anatomy	Ideal	3 (11.1)	6 (20)	3.1	.21
	Acceptable	19 (70.4)	16 (53.3)		
	Standards not met	3 (11.1)	8 (26.7)		
Margins	Ideal	3 (11.1)	7 (23.3)	4.4	.11
	Acceptable	20 (74.4)	16 (23.3)		
	Standards not met	2 (7.4)	7 (23.3)		
Point of contact	Ideal	0 (0)	4 (13)	3.5	.16
	Acceptable	2 (7)	2 (7)		
	Standards not met	23 (85)	24 (80)		
Finishing	Ideal	0 (0)	4 (13.3)	4.2	.12
	Acceptable	18 (66.7)	16 (53.3)		
	Standards not met	7 (25.9)	10 (33.3)		
	Missing	2 (7.2)			
Exemplar 2					
Anatomy	Ideal	0 (0)	1 (3.3)	0.9	.61
	Acceptable	4 (14.8)	5 (16.7)		
	Standards not met	23 (82.2)	24 (80)		
Margins	Ideal	0 (0)	0 (0)	1.1	.4 ^a
	Acceptable	1 (3.7)	0 (0)		
	Standards not met	26 (96.3)	30 (100)		
Point of contact	Ideal	0 (0)	2 (6.7)	1.8	.39
	Acceptable	11 (40.7)	11 (36.7)		
	Standards not met	16 (59.3)	17 (56.7)		
Finishing	Ideal	0 (0)	0 (0)	0.2	.5 ^a
	Acceptable	1 (3.7)	2 (6.7)		
	Standards not met	26 (96.3)	28 (93.3)		
Exemplar 3					
Anatomy	Ideal	22 (81.5)	27 (90)	1.4	.47
	Acceptable	4 (14.8)	3 (10)		
	Standards not met	1 (3.7)	0 (0)		
Margins	Ideal	22 (81.5)	27 (90)	0.8	.4 ^a
	Acceptable	5 (18.5)	3 (10)		
	Standards not met	0 (0)	0 (0)		
Point of contact	Ideal	23 (85)	28 (93.3)	3.1	.2
	Acceptable	4 (7)	1 (3.3)		
	Standards not met	0 (0)	1 (3.3)		
Finishing	Ideal	9 (33.3)	15 (50)	2.4	.2
	Acceptable	17 (63)	15 (50)		
	Standards not met	1 (3.7)	0 (0)		

^aComputed for 2x2 table only: Fisher's exact test.

reproduction of B, L, O and G embrasures with better placement of the sectional matrix and wedges'.

Students identified 'standard not met' finishing using the words 'extremely', 'very', 'too', 'gross' in front of scratchy or rough. 'Surface appears very rough and irregular in all areas', 'No lustre'.

Suggesting 'try to make the resto smooth before curing it. Use appropriate instrument to adapt it well so that finishing can be smooth'. 'Smooth with flat plastic prior to curing, contour and polish once cured'. On the other hand, acceptable finishing is described as a surface with 'a little', 'minor', 'slightly', 'a bit', 'some' roughness.

TABLE 2 Chi square comparing scores awarded to photo exemplars' criteria by Group A1-INT first iteration, group B2-INT second iteration.

Suggesting polishing to improve it. 'Yes, polishing disc and shofu point could be used to take away scratches'.

Finally, students' justification of the restoration unsuitable in a clinical situation was consistent with the rest of the criteria scores. For instance, a high marginal ridge would disrupt occlusion. Unanimously, students considered the standards not met exemplar as not suitable clinically because overextended margins pose a risk of secondary caries and excess of material would disrupt occlusion. There was no mention, however, of the effect an open contact would have in the gingival health.

TABLE 3 Agreement *n*, (%) between students and predetermined scores of exemplars A1-INT first iteration, B2-INT second iteration.

	Standards not met	Acceptable	Ideal
Exemplar 1 (E1) acceptable			
Anatomy	11 (20)	35 (63.6) ^a	9 (16.4)
Margins	9 (16.4)	36 (65.5) ^a	10 (18.2)
Point of contact	47 (85.5)	4 (7.3) ^a	4 (7.3)
Finishing	17 (30.9)	34 (61.8) ^a	4 (7.3)
Exemplar 2 (E2) standards not met			
Anatomy	47 (82.5) ^a	9 (15.8)	1 (1.8)
Margins	56 (98.2) ^a	1 (1.8)	0 (0)
Point of contact	33 (57.9) ^a	22 (38.6)	2 (3.5)
Finishing	54 (94.7) ^a	3 (5.3)	0 (0)
Exemplar 3 (E3) ideal			
Anatomy	1 (1.8)	7 (13.3)	49 (86) ^a
Margins	0 (0)	8 (14)	49 (86) ^a
Point of contact	1 (1.8)	5 (8.8)	51 (89.5) ^a
Finishing	1 (1.8)	32 (56.1)	24 (42.1) ^a

^aAgreement with predetermined scores.

Summarising, students validated their scores by providing consistent justifications and advising solutions pertinent to the problems they identified.

3.3 | The impact assessing exemplars has on students' ability to restore a tooth with composite

3.3.1 | Students' performance first iteration

A Chi square test of scores between A1-INT and B1-CT group awarded by both students and tutors showed no significant differences. Both groups in first iteration tended to significantly underrate their anatomy χ^2 (2, *N*=57)=9.64, *p*=.008, and clinical suitability with χ^2 (1, *N*=57)=12. Fisher's exact test *p*=.01 compared with their tutors scores.

3.3.2 | Students' performance second iteration

A Chi square score between B2-INT and A2-CT group awarded by both students and tutors showed no statistically significant differences. Both groups tended to significantly χ^2 (4, *N*=57)=10.1, *p*=.038 underrated the finishing of the restoration and clinical suitability with χ^2 (1, *N*=57)=6.09. Fisher's exact test *p*=.02 compared with their tutors' scores.

3.3.3 | Students' performance after six sessions of practice

When assessing 'Margins' and 'Point of contact' students tended to significantly overrate their work and clinical suitability. 'Margins' χ^2 (4, *N*=57)=18.5, *p*<.001 and 'Point of contact' χ^2 (4, *N*=57)=19.81,

Would this restoration be suitable in a clinical situation?

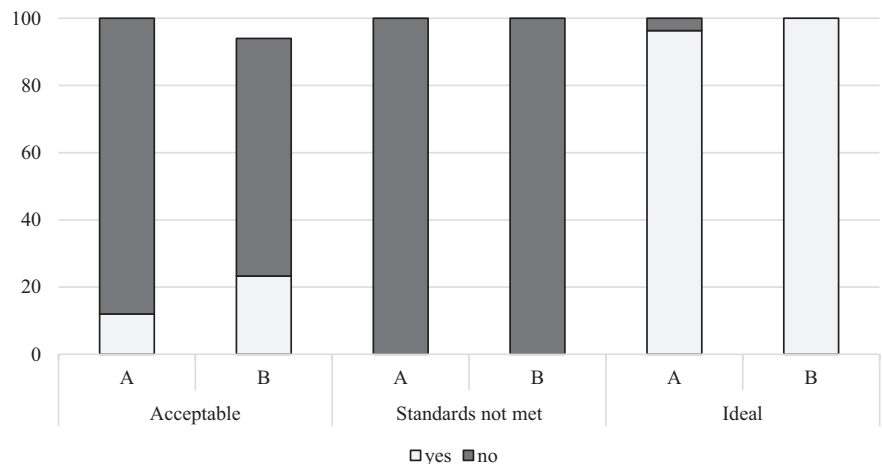


FIGURE 2 Students judgement of exemplars clinical suitability A1-INT first iteration, B2-INT second iteration.

*Predetermined score for Acceptable and ideal: Yes, Standards not met: No.

$p < .001$. Clinical suitability $\chi^2 (1, N=57)=12.2$ Fisher's exact test $p=.017$.

Finally, a *t*-test, ($p=.87$) showed no significant differences between the final composite restoration examination's results of student using assessment of exemplars to aid feedback, and the previous year.

A post hoc power analysis (Fisher's exact test and Post hoc test) of the sample size used in this study showed a power of approximately 77.8% in most the test variables. Comparing to the conventional 80% of the power to be adequate, this is a reasonable power to detect the difference between intervention and control group, and a good indicator of the outcomes reported.

4 | DISCUSSION

This study aimed to investigate students' ability to judge the quality of photographic exemplars. Additionally, it investigated the impact judging exemplars' quality had on students' ability to restore prepared ivory teeth with composite resin and self-assess them.

No significant differences between control and intervention groups were found. Students judging the quality of exemplars immediately before restoring a tooth did not affect the student ability to perform. Furthermore, students' ability to assess the quality of photographic exemplars of restorations appears not to be affected by previously attempting a similar restoration. The ability to perform, unsurprisingly, is highly determined by opportunities to practice. This is congruent with the literature indicating that appraising exemplars enhance learning provided students not only have the knowledge to discern quality but also opportunities to practice.^{5,14} In this study, students have two opportunities to restore compound preparations with composite and no significant differences were found between intervention and control group performances in either of the iterations.

Differences were noted, however, between students' awarded scores and predetermined scores of photographic exemplars particularly when assessing medium quality (Acceptable). More notably, if any of the individual criterion was scored by students as standards not met, students deemed the whole restoration clinically unacceptable. This consistency is evidence of students' sound judgement because, despite students disagreeing with predetermined scores, the judgement of individual criterion was consistent with their global judgement of quality. As reported elsewhere,^{30,31} a global judgement of quality, such a question on clinical suitability, had the purpose of addressing the limitations of analytic grading, where the overall score of a restoration is determined by the sum of each criterion. Creating situations where restorations with high scores may be clinically unsuitable because one critical criterion is below clinically acceptable standards.

Students' scores were more likely to agree with exemplars in the extremes of quality (i.e., Ideal and Standards not met) because the defects or lack of them were more salient; hence, more likely to be identified. The exceptions were the criteria 'point of contact'—Standards not met and 'Finishing'—Ideal. Students' discrepancies

with ideal 'Finishing' could be explained by the photographic magnification providing detailed information that is not clinically significant and the inability to use tactile senses on a picture.^{27,28} 'Point of contact', on the other hand, was misjudged by students who missed an evident gap between the restoration and the adjacent tooth. Probably because the gap is obvious occlusally but not so evident from a buccal view. This highlights the importance of inspecting a restoration from different angles because as in the photograph, many restorations' defects may be visible from one view but look perfectly sound from another.

The consequences of misjudging the quality of the restoration by missing a crucial defect are clear in students' selection of strategies to address the problem. Students identifying the missing contact suggested strategies involving matrix and wedge that would have solve the problem. Those who did not identified the gap described strategies that would have not sorted the problem. While for some students understanding the quality of the work they are expected to achieve does not always result in improvement of performance,²⁰ identifying what went wrong is a good start. This is particularly important when students self-assess.

Students' self-assessment, however, may indicate other than their ability to judge the quality of their work. In this study, students tended to underrate their work in the first two iterations but overrate it after nine sessions of practice. These findings are congruent with Tuncer et al (2014) who found that students tended to overrate their work as their experience increased. This suggests that students' self-assessment may be an indicator of confidence rather than a reflection on their ability to judge quality.³²

Students demonstrated they could articulate rationale and suitable solutions consistent with their judgements. It has been argued that this has the potential to benefit students by providing opportunities to reflect and focus on what is important.²⁵ De Peralta et al. (2017) found students ability to self-asses improved when students had opportunity to reflect and apply critical thinking on feedback from multiple sources.³³ A source of feedback and reflection could be photographic exemplars.

Exemplar of excellent work, ideal, are more frequently used because they show students the standards they should aim for.³⁴ It can be argued that exemplars of mediocre quality, not in the extremes, are the ones with more didactic potential. This is because mediocre exemplars present a problem students need to identify, explain and solve and serve as an adjunct source of feedback and reflective activity.

Assessing exemplars appeared not to influence students' abilities to restore a tooth in the short term. However, they still can be a good source of feedback to instructors about students' understanding of quality. In this study, it appears that all students involved have a similar sound understanding of composite restorations quality and how to achieve it. Indicating that the learning resources were effective in conveying knowledge.

We recommend developing a pool of exemplars students can use to self-assess their evaluative skills and instructors can use to monitor whether students understand quality and how to achieve

it before practising a procedure. Other restorations or dental procedures can be included. Furthermore, exemplars can be used for new teaching staff who need to learn and become familiar with the marking criteria and assessment procedures.

This intervention was implemented during COVID-19 restrictions when all learning resources were available online, students' access to face-to-face feedback from tutors was sharply reduced and interaction with peers eliminated during their practical sessions. Disruptions during this period also reduced data that could be added for analysis. While this study showed an 77.8% power, it is suggested that similar studies with diverse procedures and learning environments could enhance our understanding of students' ability to judge the quality of photographic exemplars and their impact on preclinical skills in the long term.

5 | CONCLUSION

Despite students' ability to identify the quality of composite restorations in photographic exemplars, assessing photographic exemplars before restoring a tooth did not have an impact on students' immediate ability to perform.

Students' ability to identify the quality of exemplars and to propose sound rationales and solutions indicates to what extent students understood the intended learning outcomes and how to achieve them. Making exemplars a valuable source of feedback to instructors about the impact learning resources have on students understanding of quality.

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CONFLICT OF INTEREST STATEMENT

None of the author have a conflict of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

- Sadler DR. Specifying and promulgating achievement standards. *Oxf Rev Educ*. 1987;13(2):191-209.
- Grainger PR, Heck D, Carey MD. Are assessment exemplars perceived to support self-regulated learning in teacher education? *Front Educ*. 2018;3(60):1-9.
- Nicol DJ, Macfarlane-Dick D. Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Stud High Educ*. 2006;31(2):199-218.
- Zimmerman BJ. Theories of self-regulated learning and academic achievement: an overview and analysis. In: Zimmerman BJ, Schunk DH, eds. *Self-Regulated Learning and Academic Achievement: Theoretical Perspectives*. Taylor & Francis; 2013:1-35.
- Renkl A. Toward an instructionally oriented theory of example-based learning. *Cogn Sci*. 2014;38:1-37.
- Zimmerman BJ, Kitsantas A. Acquiring writing revision skill: shifting from process to outcome self-regulatory goals. *J Educ Psychol*. 1999;91(2):241-250.
- Rung A, Hood M, George R. A novel scale to measure students' perceptions of exemplars in a dental school. *Eur J Dent Educ*. 2021;26:608-616.
- Howe E, Lightfoot U, Dixon H. First-year students working with exemplars: promoting self-efficacy, self-monitoring and self-regulation. *J Furth High Educ*. 2019;43(1):30-44.
- Hendry GD, Jukic K, Practice L. Learning about the quality of work that teachers expect: students' perceptions of exemplar marking versus teacher explanation. *J Univ Teach*. 2014;11(2):5-68.
- Orsmond P, Merry S, Reiling K. The use of exemplars and formative feedback when using student derived marking criteria in peer and self-assessment. *Assess Eval High Educ*. 2002;27(4):309-323.
- Wimshurst K, Manning M. Feed-forward assessment, exemplars and peer marking: evidence of efficacy. *Assess Eval High Educ*. 2013;38(4):451-465.
- Hendry GD, Armstrong S, Bromberger N. Implementing standards-based assessment effectively: incorporating discussion of exemplars into classroom teaching. *Assess Eval High Educ*. 2012;37(2):149-161.
- Hendry GD, Bromberger N, Armstrong S. Constructive guidance and feedback for learning: the usefulness of exemplars, marking sheets and different types of feedback in a first year law subject. *Assess Eval High Educ*. 2011;36(1):1-11.
- Handley K, Williams L. From copying to learning: using exemplars to engage students with assessment criteria and feedback. *Assess Eval High Educ*. 2011;36(1):95-108.
- To J, Carless D. Making productive use of exemplars: peer discussion and teacher guidance for positive transfer of strategies. *J Furth High Educ*. 2016;40(6):746-764.
- Carless D, Boud D. The development of student feedback literacy: enabling uptake of feedback. *Assess Eval High Educ*. 2018;43(8):1315-1325.
- Carless D, Chan KKH. Managing dialogic use of exemplars. *Assess Eval High Educ*. 2017;42(6):930-941.
- Hendry GD, Anderson J. Helping students understand the standards of work expected in an essay: using exemplars in mathematics pre-service education classes. *Assess Eval High Educ*. 2013;38(6):754-768.
- Ajjawi R, Tai J, Dawson P, Boud D. Conceptualising evaluative judgement for sustainable assessment in higher education. In: Boud D, Ajjawi R, Dawson P, Tai J, eds. *Developing Evaluative Judgement in Higher Education*. Routledge Taylor & Francis group; 2018:23-33.
- Hendry GD, White P, Herbert C. Providing exemplar-based 'feed-forward' before an assessment: the role of teacher explanation. *Act Learn High Educ*. 2016;17(2):99-109.
- Yucel R, Bird FL, Young J, Blanksby T. The road to self-assessment: exemplar marking before peer review develops first-year students' capacity to judge the quality of a scientific report. *Assess Eval High Educ*. 2014;39(8):971-986.
- Mattheos N, Nattestad A, Christersson C, Jansson H, Attström R. The effects of an interactive software application on the self-assessment ability of dental students. *Eur J Dent Educ*. 2004;8(3):97-104.
- Rung A, George R. A systematic literature review of assessment feedback in preclinical dental education. *Eur J Dent Educ*. 2021;25(1):135-150.
- Shah DY, Dadpe AM, Kalra DD, Garcha VP. Videotaped feedback method to enhance learning in preclinical operative dentistry: an experimental study. *J Dent Educ*. 2015;79(12):1461-1466.

25. Huth KC, Baumann M, Kollmuss M, Hickel R, Fischer MR, Paschos E. Assessment of practical tasks in the Phantom course of Conservative Dentistry by pre-defined criteria: a comparison between self-assessment by students and assessment by instructors. *Eur J Dent Educ*. 2017;21(1):37-45.
26. Mays KA, Branch-Mays GL. A systematic review of the use of self-assessment in preclinical and clinical dental education. *J Dent Educ*. 2016;80(8):902-913.
27. Moncada G, Silva F, Angel P, et al. Evaluation of dental restorations: a comparative study between clinical and digital photographic assessments. *Oper Dent*. 2014;39(2):e45-e56.
28. Signori C, Collares K, Cumerlato CBF, Correa MB, Opdam NJM, Cenci MS. Validation of assessment of intraoral digital photography for evaluation of dental restorations in clinical research. *J Dent*. 2018;71:54-60.
29. Saldaña J. *The Coding Manual for Qualitative Researchers*. Sage; 2015.
30. Chambers DW, LaBarre EE. The effects of student self-assessment on learning in removable prosthodontics laboratory. *J Dent Educ*. 2014;78(5):668-680.
31. Geissler P. Student self-assessment in dental technology. *J Dent Educ*. 1973;37(9):19-21.
32. Tuncer D, Arhun N, Yamanel K, Celik C, Dayangac B. Dental students' ability to assess their performance in a preclinical restorative course: comparison of students' and faculty members' assessments. *J Dent Educ*. 2015;79(6):658-664.
33. De Peralta TL, Ramaswamy V, Karl E, Van Tubergen E, McLean ME, Fitzgerald M. Caries removal by first-year dental students: a multi-source competency assessment strategy for reflective practice. *J Dent Educ*. 2017;81(1):87-95.
34. Boud D, Ajjawi R, Dawson P, Tai J. *Developing Evaluative Judgement in Higher Education: Assessment for Knowing and Producing Quality Work*. Routledge; 2018.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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