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Misconceptions amongst dental students: How can they be identified?

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Abstract

Aim: To compare the frequency of misconceptions amongst dental students resulting from assessments in different subject areas using different types of multiple-choice questions (MCQs). We wanted to know whether misconceptions, or strongly held incorrect beliefs, differed by subject area or question type.

Methods: A total of 104 students completed two assessments that included 20 MCQs on endodontics and 20 MCQs on dental implants. On each examination, 10 questions were scenario-type questions requiring interpretation or analysis and 10 questions were factual-based, knowledge questions. Incorrect responses and confidence levels by student and subject were recorded for a comparison of average misconceptions by question type and for correlations between scenario and knowledge question types for misconceptions on both assessments.

Results: Students were overly confident on their incorrect responses and misconceptions for both assessments. On the endodontic examination, students held a statistically significant higher number of mean misconceptions on scenario questions than for knowledge questions, but the difference was not statistically significant for the dental implant examination. There was a moderately weak relationship between scenario and knowledge questions for misconceptions on the endodontic (r=.31) and dental implant (r=.20) assessments, suggesting students who have misconceptions on knowledge questions are somewhat more likely to have misconceptions on scenario questions.

Conclusion: Students had a consistent rate of overconfidence (75%) in their incorrect responses regardless of question type or dental subject. Questions that prompted a higher per cent of incorrect responses were more likely to detect misconceptions, as students were highly confident in their mistakes, for both assessments.

KEYWORDS

confidence, dental education, misconceptions, multiple-choice questions

1 | INTRODUCTION

Dental education has traditionally emphasised building foundation knowledge rather than identifying and mitigating student misconceptions.[1,2] Students' misconceptions result from a misunderstanding or misinterpretation of information, and, generally, the error originates from previous learning. Misconceptions occur when students believe they understand when, in fact, they do not accurately comprehend the underlying concept. Often, misconceptions are difficult to detect and usually are resistant to change.[3] Students may distort or ignore new information that conflicts with their previous erroneous thinking.[4] As a result, misconceptions can be a barrier to understanding, interfering with student learning.[3,5]

Measuring confidence together with correctness through assessment may help faculty identify student misconceptions. Confidence is defined as the state of feeling certain about the truth

of something. Confidence and correctness may interact in four ways, each with different implications for student learning outcomes. First ideally, a correct and confident student is one who knows correct information and is confident in the accuracy of the information. Calibration between correctness and confidence is an important attribute for appropriate clinical decision-making and professional development.[6-8]

Second, the learning process is notably enhanced when a student is incorrect and not confident because the student is uninformed yet generally open-minded and receptive to learning.[9] Third, a student who is correct and not confident is merely guessing, contributing to an unfavourable condition where faculty may not detect the student's deficiency, with no feedback of error to prompt change.[2] Fourth, the student who is incorrect and confident, characterising a misconception, is less likely to seek additional opinions before initiating treatment and therefore is unaware of their responsibility for adverse outcomes of errors in their planning or thinking.[8] Lack of calibration between confidence and correctness may lead to inappropriate clinical decisions, exposing patients to harmful and unnecessary procedures.[2,7]

Identifying misconceptions in dental education is important to help disclose topics resulting in the most misunderstanding.[2] Educators can then create strategies to provide appropriate feedback to students regarding their specific lack of knowledge and encourage more informed performance, by pointing out the misconception and an implied aetiology. Feedback can encourage the development of self-assessment skills, allowing students to evaluate the extent of their current knowledge and lack thereof for remedial action, that is to recognise and admit what they do not know and how to remedy deficiencies.[10] Misconception-based feedback may increase students' interest in fostering critical thinking aligned with lifelong learning for their professional career development.[11] Despite potential benefits of identifying misconceptions, they have not been broadly investigated in dental education.

Few studies have specifically examined misconceptions.[2,3,5,8] Some studies in the areas of medicine, psychology and nursing have evaluated the interaction between confidence and correctness.[7,9,11-14] Ibabe and Sporer[12] observed psychology students' theoretical assessments and showed that confidence varied as a function of question form. With open-ended questions, level of confidence in correct answers was lower than with either true/false or four alternative forced-choice questions. Interestingly, this variation across question form was not observed for confidence in incorrect responses. Their findings suggest there is not a single best type of question to detect misconceptions.

The literature is unclear about the type of assessment most suited to identify students' misconceptions. Although researchers have compared open-ended to multiple-choice questions (MCQs),[12] we wanted to compare different types of MCQs. Therefore, to understand how MCQs might be used to identify misconceptions, we compared scenario questions to knowledge-based questions on an endodontic assessment and dental implant assessment.

2 | METHODS

2.1 | Study design and sample

This cross-sectional study was conducted using a convenience sample of 105 third-year University of California, San Francisco (UCSF), dental students (59 male, 46 female) from the graduating class of 2011. The sample was composed of 82 traditional pre-doctoral students and 23 international students. The protocol for the study was reviewed and approved by the UCSF Committee of Human Research (IRB#14-15225, Reference#123820).

2.2 | Assessment instrument

The two assessments included 20 MCQs on endodontics and 20 MCQs on dental implants. On each examination, 10 questions were scenario-type questions requiring interpretation or analysis and 10 questions were factual-based, knowledge questions requiring simple recall of information.

Questions were selected from an existing bank of questions that had been used previously and for which reliability scores ranged from .65 to .80.[2] Two faculty members independently designated the MCQ as either scenario or knowledge questions, and agreement was achieved by consensus.

For each question, there were four possible responses: one most appropriate answer and three incorrect distracters. After the student had chosen a response from amongst the four alternatives, they indicated their level of confidence for each choice, answering an additional question: How confident are you about your previous answer? () Very sure; () Sure; () Unsure or () Very unsure.[8] For statistical purposes, these categories were later dichotomised to "confident" and "not confident." Students were advised that confidence levels would be an important factor to consider; however, confidence would not influence their grades. Misconceptions were defined as a combination: incorrect answer+confident.

Data were compiled in Excel files using code numbers replacing students' names to maintain confidentiality.

2.3 | Data analysis

Descriptive analysis for incorrect responses, confidence and misconceptions were reported separately for both groups, endodontic and dental implant assessments, taking into consideration the type of question (scenario or knowledge).

Statistical *t* tests (paired two sample for means) were used to compare misconceptions' mean differences between categories of scenario and knowledge types of questions, separately for endodontic and dental implant assessments. Significance level was set at $P<.05$.

In addition, descriptive analysis was used to analyse misconceptions as a per cent of incorrectness across all categories to determine whether the relative number of misconceptions resulted from an increased number of incorrect answers. For example, misconceptions as a percentage of incorrectness were analysed for all possible iterations

of data: individually (endodontic scenario; endodontic knowledge; dental implant scenario; dental implant knowledge) or in combination (endodontic scenario/knowledge; dental implant scenario/knowledge; endodontic/implant scenario/knowledge).

Pearson's correlation coefficient was used to measure the association between students' misconceptions in knowledge questions and students' misconceptions in scenario questions, for the endodontic and dental implant assessments.

3 | RESULTS

On the endodontic assessment, there were 2100 responses resulting from 105 students answering 20 questions. On the dental implant assessment, there were 2080 responses from 104 students answering 20 questions.

Tables 1 and 2 identify incorrect responses, confidence and misconceptions for endodontic and dental implant assessments by scenario and knowledge question type. For the endodontic assessment, mean confidence level was 88.5% and mean number of misconceptions was 9.7 from the 105 answers, for each question, in scenario questions; and for the 10 knowledge questions, mean confidence and misconception values were 94.0% and 5.4, respectively. For the dental implant assessment, mean confidence level was 82.6% and mean number of misconceptions was 22 from the 104 answers, for each question, in scenario questions; and for the 10 knowledge questions, mean confidence and misconception values were 83.4% and 23.2, respectively.

TABLE 1 Endodontic examination summary of incorrect responses, confidence levels and number of misconceptions by question type

Type of question	Question	Incorrect responses number/ total	Confidence per cent	Misconceptions number (incorrect answer+confident)
Scenario	Q1	1/105	90	0
	Q2	1/105	95	0
	Q3	3/105	90	3
	Q4	11/105	88	7
	Q5	17/105	78	9
	Q7	26/105	80	21
	Q8	57/105	78	42
	Q9	2/105	98	2
	Q19	5/105	93	3
	Q20	10/105	95	10
	Mean		88.5	9.7
Knowledge	Q6	18/105	90	14
	Q10	3/105	95	3
	Q11	6/105	93	3
	Q12	2/105	95	2
	Q13	1/105	98	1
	Q14	5/105	93	4
	Q15	17/105	95	16
	Q16	8/105	93	3
	Q17	7/105	93	6
	Q18	4/105	95	2
	Mean		94.0	5.4

Statistical *t* tests (paired two sample for means) in a comparison of misconceptions between categories of scenario and knowledge question types at the level of student within question showed a statistically significant mean difference in misconceptions by question type for the endodontic assessment ($P<.0001$), but the difference was not statistically significant for the dental implant assessment ($P>.05$). Whilst mean misconceptions for scenario questions were about twice that of knowledge questions for the endodontic assessment, a misconception mean difference was virtually nonexistent for the dental implant assessment (Tables 1 and 2).

Misconceptions as a per cent of incorrect responses were high for all possible combinations of data. That is, regardless of endodontic or dental implant assessments, or scenario or knowledge question types, misconceptions were approximately 75% of incorrect responses. More specifically, misconceptions as a per cent of incorrect responses were approximately 75% for the following iterations of analysis: endodontic scenario, endodontic knowledge, dental implant scenario, dental implant knowledge, endodontic scenario/knowledge combined, dental implant scenario/knowledge combined and endodontic/dental implant scenario/knowledge combined (Figure 1).

Finally, correlations between knowledge and scenario questions for misconceptions on the endodontic assessment ($r=.31$) and the dental implant assessment ($r=.20$) were moderately weak.

4 | DISCUSSION

This study was motivated by the challenge of identifying misconceptions in academic dentistry programmes. Detecting and understanding misconceptions is a way to motivate students' critical thinking by identifying their mistaken views, improving, therefore, clinical decision-making.[11] Our question was whether knowledge or scenario questions were better for identifying misconceptions on endodontic and dental implant assessments. We expected that students would exhibit more misconceptions on scenario questions as compared to knowledge questions on both endodontic and implant assessments. It was anticipated there would be more incorrect responses and a higher level of confidence on scenario questions than on knowledge-based questions.

Indeed, in a comparison with misconceptions between scenario and knowledge question types, there was a statistically significant mean difference only for endodontic assessment, where the mean misconceptions for scenario questions were nearly double that for knowledge questions. Another finding of interest was that students had three times as many total absolute misconceptions for the dental implant assessment (447; n=104) compared to the endodontic assessment (151; n=105), although misconceptions as

TABLE 2 Dental implant examination summary of incorrect responses, confidence levels and misconceptions by question type

Type of question	Question	Incorrect responses number/ total	Confidence per cent	Misconceptions number (incorrect answer+confident)
Scenario	Q1	70/104	80	60
	Q6	59/104	77	45
	Q9	78/104	65	37
	Q10	3/104	90	3
	Q11	38/104	80	29
	Q12	15/104	85	14
	Q13	6/104	87	3
	Q14	12/104	82	10
	Q15	8/104	95	8
	Q18	18/104	85	11
	Mean		82.6	22.0
Knowledge	Q2	37/104	85	30
	Q3	17/104	80	6
	Q4	30/104	85	26
	Q5	7/104	87	6
	Q7	33/104	77	27
	Q8	94/104	75	65
	Q16	0/104	95	0
	Q17	26/104	85	24
	Q19	10/104	90	8
	Q20	60/104	75	41
	Mean		83.4	23.2

a per cent of incorrect responses were the same (74%) (Figure 1). Based on this, we interpreted increased misconceptions followed from increased incorrect responses, not because of differing levels of confidence. Differing levels of incorrectness, not confidence differences, was the reason we observed the mean differences in misconceptions between question types on the endodontic examination.

In other words, dental students had a constant rate of overconfidence (75%) in incorrect responses regardless of question type or dental discipline, even though there are mean and total differences in their incorrect responses. Therefore, scenario questions were better to detect misconceptions, but only because students were more likely to make incorrect choices in scenario questions, as their confidence was high for both question types. Additionally, in practice, it must be emphasised that those students who choose incorrect responses for scenario questions are moderately more likely to make incorrect choices for knowledge questions, due to the moderately weak relationship found between scenario and knowledge questions for endodontic (r=.32) and dental implant (r=.35) assessments measuring both incorrectness and misconceptions.

The students showed high levels of confidence in their incorrect choices. This "overconfidence" of students is the degree to which people overestimate their performance on cognitive tasks, and it has been increasingly investigated in psychological and medical studies over the past 30 years.[15] The literature has reported that about 70% of the individuals possess or express overly positive judgements of their abilities,[14] because they are unable to accurately assess their own competence, arriving at the biased self-view. This biased view occurs because people lack competence to identify their own incompetence.[16] Also, some people are overly confident because it provides them with some psychological benefits such as improving task motivation, improving persistence[17] and being able to convince others that they are more capable than they really are.[18] As an individual's overconfidence is linked to the lack of comprehension of their own cognitive limitations,[14] we can assume that the highly confident dental student from this current investigation might be inclined to make mistakes, thinking they were doing well. Authors have claimed that it is important to reduce excessive overconfidence, aiming to reduce risk-taking, whilst maintaining curiosity and openness, characteristics important to learning. An individual of lower ability that is highly confident is more likely to engage in activities. Conversely, an informed individual lacking confidence may be less likely to engage in activities, sometimes taking conservative approaches to challenges.[19]

The ideal situation would be a student with a balanced perception of his/her abilities, or with a "moderate" confidence level. In this regard, we claim that our study is powerful in showing that misconceptions are linked with high levels of confidence. Furthermore, we suggest that three steps faculty can take to help students reflect on their errors: (i) identify students' misconceptions (incorrectness+confidence), (ii) provide appropriate and specific feedback to students regarding their "biased view" and (iii) motivating students to think critically and to consider an exercise of self-assessment.

According to Eva and Regehr,[20] in daily practice, having a clear and accurate sense of one's strengths allows the professional to act with appropriate confidence. To promote the development of dental students' (oral and maxillofacial pathology course) self-assessment behaviour and skills to recognise and to admit what they do not know, authors have proposed the implementation of a confidence-scoring algorithm for multiple-choice examinations.[11] With a similar approach, but using a different methodology from ours, their algorithm assigned one point for a correct answer, deducted fractional points for an incorrect answer, but rewarded students fractional points for leaving the question unanswered in admission that they were unsure of the correct answer.

The strengths of this current study included the use of authentic data from the academic assessments (final exams of endodontic and dental implant areas), which reflect the real scenario as accurately as possible and has students appropriately engaged. In addition, our choice of not statistically comparing misconceptions between endodontic and dental implant assessments avoided confounding that likely exists between complexities of separate subject domains. Either way, we could observe that students had three times as many total absolute misconceptions for dental implant assessment. Two logical explanations for this fact are as follows: (i) the dental implant multiple-choice assessment might have been more difficult and

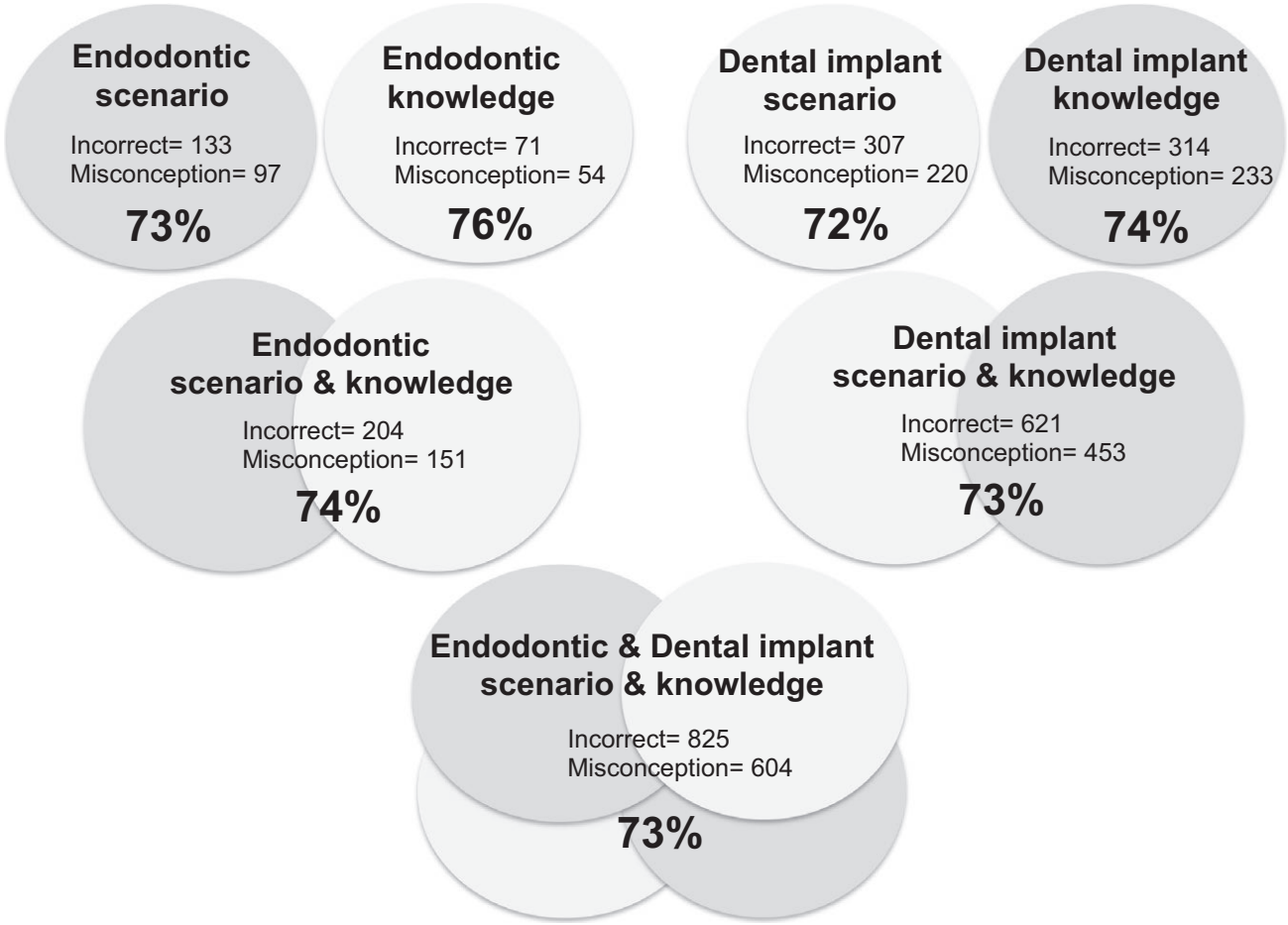

FIGURE 1 Misconceptions (incorrect answer+confident) as a percentage of incorrect responses for all possible combinations of data

complex than the endodontic assessment and, (ii) because this study was conducted with students during their last year of theoretical instruction on the subject being studied, students were more comfortable and familiar with endodontic topics. As endodontic topics are taught sooner in dental curriculum as compared to dental implant topics, at the time of our investigation, students had already had more research, debate, questionings, and, also practice in endodontics.

Limitations of this study included using a convenience sample and having results only from just two assessments. Our results may or may not be generalised to other dental institutions or other subject areas. Forthcoming investigations will explore confidence and misconceptions over time (with or without receiving feedback) and in different topics/clinical procedures in different subject areas.

The increased number of misconceptions identified on scenario questions than knowledge questions on the endodontic examination was a result of a higher number of incorrect answers, and not the result of question type. More incorrectness in scenario questions might be due to the requirement for students to interpret complexities of patient signs symptoms, radiographs and photographs. In other words, scenario questions demands higher levels of cognitive function such as comprehension, application and synthesis of information.[21,22]

In sum, aside from reinforcing our previous suggestion of an assessment that pairs a MCQ and a confidence question to detect misconceptions,[2,8] this study contributed to a better understanding about misconceptions and it was able to show that scenario questions in endodontic assessment were more able to detect misconceptions, but only because students were more likely to make incorrect choices in scenario questions. Particularly for the subjects of this study, a question that prompted more incorrect responses was more appropriate to detect misconceptions, as students were highly confident in their mistakes, for either endodontic or dental implant assessments.

5 | CONCLUSION

Multiple-choice assessments can be used to identify students' misconceptions; but scenario-type questions were not better able to identify misconceptions than knowledge-based questions. Students were consistently overconfident in different subject domains and with different types of questions.

CONFLICT OF INTEREST

The manuscript has not been submitted to any other journals, and will not be submitted elsewhere whilst under consideration by the European Journal of Dental Education. All authors have read and

approved the manuscript as submitted and take full responsibility for it. Moreover, the authors declare that they do not have conflict of interests associated with the publication of the article.

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