Exam questions developed by students lead to higher cognitive level of learning

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ABSTRACT

New dental education accreditation standards emphasize that graduates must be competent in the use of critical thinking (high cognitive level skill). Despite the new standards, most written assessments in dental school courses are still based on low cognitive-level questions.[1]

The goal of this project was to determine if an exercise that allows students to collaboratively write exam questions leads to higher levels of learning. To evaluate this exercise, cognitive level of exam questions and students' scores across two groups were compared: a "control" group in which tests were instructor-generated and an "intervention" group in which students contributed to test development.

Results indicate that the intervention group took exams with higher-level cognitive questions and performed better compared to the control group. **Students generating their own assessments developed higher cognitive-level exam questions and performed better on the exams, suggesting expansion of this exercise into other dental classroom experiences.**

BACKGROUND

- Student assessment is directly associated with student learning

- Dental school assessments are based on low cognitive-level questions due to:
    - Difficulty in developing higher-cognitive questions
    - Poor performance of students on higher-cognitive questions[2]

- New dental accreditation standards emphasize competent use of critical thinking
    - Commission on dental accreditation suggests "the use of questions that require students to analyze problem etiology, compare and evaluate alternative approaches, provide rational for plans of action, and predict outcomes"[3]

WE HYPOTHESIZED:

1) Student-generated exam questions lead to higher cognitive level of assessments, compared to instructor-generated assessments

2) Student-generated exam questions at a higher-cognitive level lead to increased learning demonstrated by scoring as good or better on high cognitive level exam questions, compared to students tested on lower cognitive-level questions

3) Students perceive exam question development helpful to their learning

METHODS

1) GROUP WORK:
- Student groups (intervention group) constructed and edited a list of exam questions to study from and use for midterm and final exams
    - Students created simulated clinical scenarios from assigned lectures, clinical/lab, and related knowledge
    - Students generated 5 multiple-choice questions based on simulated scenario or other course content
- Extra credit given to groups generating questions at high cognitive levels

2) RATING EXAM QUESTIONS:
- Cognitive level of 160 exam questions from intervention and control (instructor-generated exams) groups scored blindly by three expert scorers (weighted kappa=0.88)
- Questions given cognitive score based on modified Bloom's taxonomy (*Figure 1*)[4,5]
    - Level 1: low cognitive level (measuring knowledge and comprehension)
    - Level 2: medium cognitive level (measuring application and analysis)
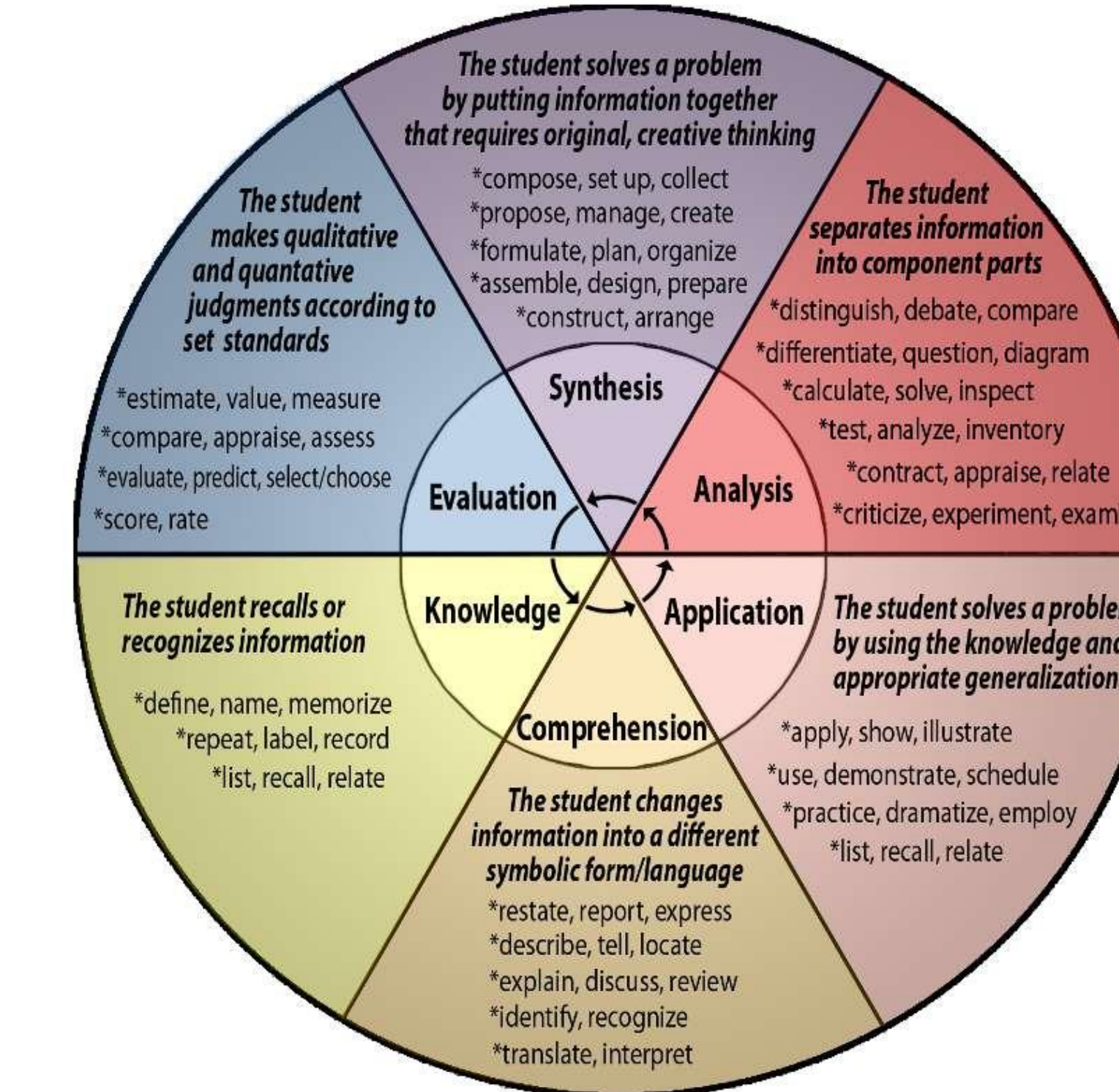   - Level 3: high cognitive level (measuring synthesis and evaluation)

3) QUALITATIVE DATA:
- Intervention students completed a survey to capture perceptions related to learning, ease, and utility of exercise (69% survey respondents)

4) STATISTICAL METHODS:
a) Intervention and control groups were compared in entering DAT and GPA, winter semester and D1 year GPA
b) Cognitive level of student-generated exam questions compared to instructor-generated questions using Mann-Whitney
c) Students' performance on exams in the intervention group compared controls using Mann-Whitney
d) Students' perceptions of exercise were analyzed for additional descriptive statistics

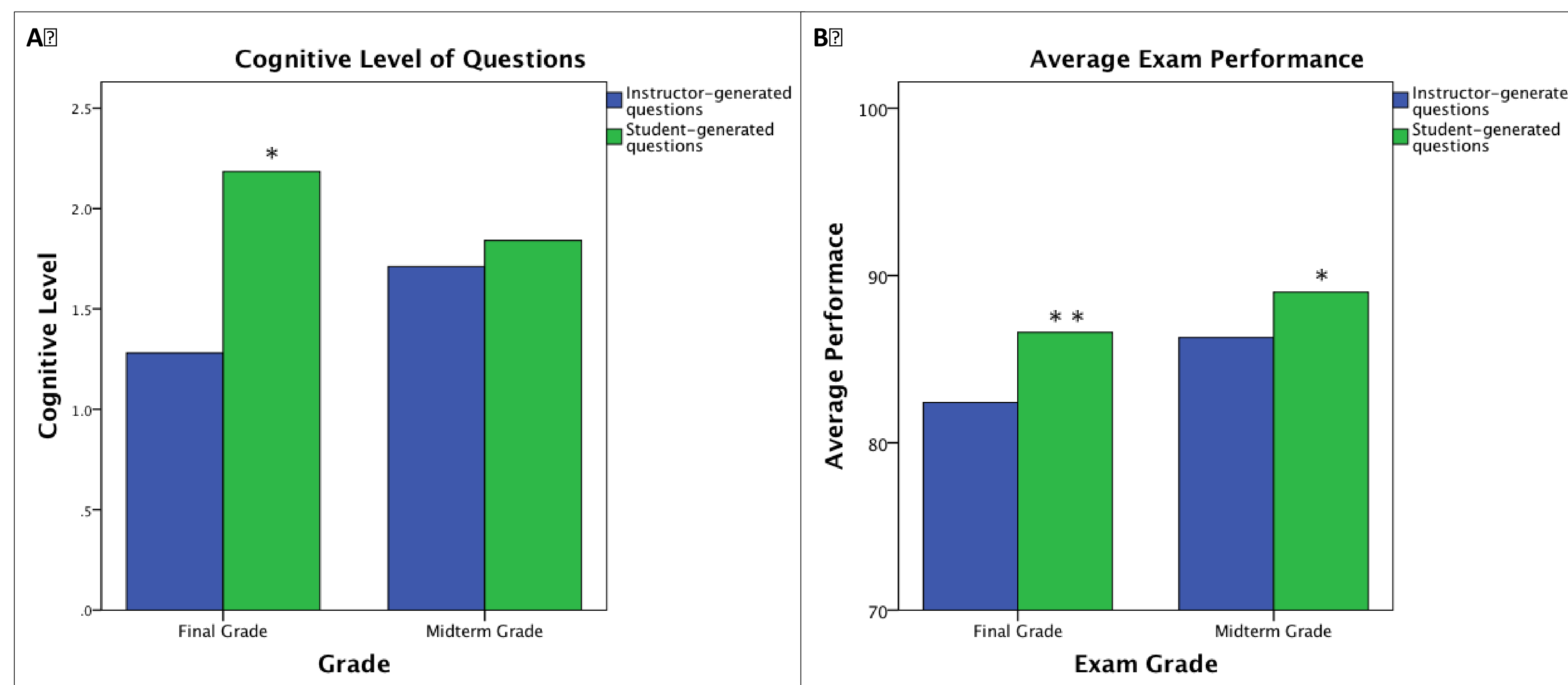*Figure 1: Criteria of cognitive levels based on Bloom's taxonomy*[4,5]

RESULTS

Table 1. Demographics of intervention and control groups

Demographic	Control Group	Intervention
Entering GPA	3.47	3.56
DAT	19.6	20.3*
DAT-Perceptual Ability	19.9	20.6*
1st Year Dental GPA	3.47	3.50
1st Year Winter Semester GPA	3.41	3.47

*Intervention group is significantly different from the control group (p<0.05)

Figure 2. Group of students generating exam questions

Figure 3. A) Cognitive level of instructor- and student-generated questions as scored by blinded experts; B) Average performance of student on instructor-generated (control group) and student-generated (intervention group) exam questions

*Indicates significant difference in the student intervention group compared to instructor-generated questions (p<0.05)
**Indicates marginal significant difference (p=0.07)

SURVEY RESULTS

- A majority (79%) of students agreed that the exercise was helpful for their overall learning experience

- When asked about helpfulness of the exercise's components, teamwork was the only one rated significantly differently. Other components include working in teams, using Google Docs, getting feedback from instructors, getting extra credit for higher-level cognitive questions, and seeing exam questions (*Table 2*)

Table 2. Mean ratings for students' perceived helpfulness of exercise components (Likert Scale: 1=Strongly Disagree….5=Strongly Agree)

Working in teams	Using Google Docs	Getting extra credit	Getting instructor feedback	Seeing exam questions before taking exam
2.51*	2.79	3.16	3.19	3.34

*Indicates significant difference compared to all other components as indicated by repeated measures ANOVA (p<0.05)

"I think that this exercise was the best learning tool I've seen here. I really learned well having to critically analyze the material myself in order to make questions."

DISCUSSION

1) Comparisons of students' prior abilities were inconclusive. Average entering DAT score is slightly higher for the student intervention group, but statistically significant, while differences in entering GPA were not significant (*Table 1*).

2) Student-generated exams were written at higher cognitive levels and students performed better on them, suggesting increased learning (*Figure 3A and 3B*).

3) Students' perceptions of the exercise were overall positive. A repetition effect -- i.e., seeing the questions before the exams -- could potentially explain the increased performance on exam questions, but as indicated by *Table 2*, students did not perceive this to be the case. This component was not rated significantly differently than other aspects of the learning experience.

Overall, students generated higher cognitive-level exam questions and performed better on them, suggesting student-driven, collaborative assessments are an important tool for building critical thinking skills in dental classrooms.

REFERENCES

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