Oral exams for large-enrollment engineering courses to promote academic integrity and student engagement during remote instruction

Marko Lubarda, Nathan Delson, Curt Schurgers, Maziar Ghazinejad, Saharnaz Baghdadchi, Alex Phan, Mia Minnes, Josephine Relaford-Doyle, Leah Klement, Carolyn Sandoval, Huihui Qi

University of California, San Diego – La Jolla, CA, USA

Emails: {mlubarda, ndelson, cschurgers, mghazinejad, sabaghda, mgphan, minnes, jrelaford, lklement, c2sandoval, huqi}@ucsd.edu

***Abstract*—This work-in-progress paper presents an innovative practice of using oral exams to maintain academic integrity and promote student engagement in large-enrollment engineering courses during remote instruction. With the abrupt and widespread transition to distance learning and assessment brought on by the COVID-19 pandemic, there has been a registered upsurge in academic integrity violations globally. To address the challenge of compromised integrity, in the winter quarter of 2021 we have implemented oral exams across six mostly high-enrollment mechanical and electrical engineering undergraduate courses. We present our oral exam design parameters in each of the courses and discuss how oral exams relate to academic integrity, student engagement, stress, and implicit bias. We also address the challenge of scalability, as most of our oral exams were implemented in large classes, where academic integrity and student-instructor disconnection have generally gotten disproportionately worse during remote learning. Our survey results indicate that oral exams have positively contributed to academic integrity in our courses. Based on our preliminary study and experiences, we expect oral exams can be effectively leveraged to hinder cheating and foster academic honesty in students, even when in-person instruction and assessment resumes.**

Keywords—Oral exams, academic integrity, student engagement, student-faculty interaction, engineering education.

I. Introduction

Oral exams are an underutilized assessment strategy in STEM higher education [1], [2], [3], despite a mounting body of research identifying a spectrum of benefits derivable from the pedagogical practice, such as enhanced student effort and intellectual engagement [2], [4], [5] increased motivation to learn at a deeper level [6], [7], [8], [9], [10], improved technical speaking competence [2], [7], [11], enhanced assessment power [2], [6], [7], [11], and security against cheating [5], [7], [11], [12]. Reports on the implementation of oral exams in engineering courses are scarce [1], [3], [13], [14], especially for large-enrollment courses. However, following recent campus shutdowns due to the COVID-19 pandemic, oral exams have attracted more attention as a possible solution, among others, for combating academic dishonesty during remote course delivery [15], [16], [17]. Implementations of oral exams amid the pandemic have been reported in a postgraduate finance course [5], in an undergraduate biochemistry course [12], as well as a mathematics course [18]. In addition to curbing cheating, oral exams were reported to have been introduced in these courses to test theoretical knowledge, improve interaction during isolation occasioned by the pandemic, and develop students' oral communication skills. We have similarly sought to improve academic integrity and promote engagement and learning among our engineering students through the incorporation of oral exams in six remotely offered, mostly large-enrollment undergraduate courses. In this work-in-progress paper, oral exam implementation points are discussed in connection to scaling oral exams to large classes and addressing concerns about student stress and examiner bias. We have analyzed students' perceptions about their oral exam experience. Our results indicate that the oral exams were well received by most of our students, many of whom found them beneficial to their learning and motivation, as well as to academic integrity in the class. Implications of our work for post-COVID-19 instruction is discussed.

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II. Context and Methodology

We explore the perceptions of undergraduate students about oral exams and their assessment experience in six undergraduate mechanical and electrical engineering courses delivered remotely in the winter quarter of 2021, during the COVID-19 pandemic. The format of the administered oral exams was interrogative [19], with each student questioned by the instructor or one of the instructional assistants via the video-conferencing platform Zoom. In some of the courses, the oral exam questions were based on or extensions to written exam problems, whereby they helped to authenticate students' written exam work, whereas in other courses the oral exams were implemented independently from the written exams. Basic information about the courses, along with the design parameters of oral exams implemented in them, is summarized in Table I.

To gather students' feedback on points of interest to the study, a survey instrument was developed consisting of a pre-exam, post-exam, and end-of-quarter survey. The first and third of these were administered once at the beginning and end of the quarter, whereas the post-exam survey was conducted after each oral exam so that students' perspectives could be tracked over time. All surveys were voluntary and anonymous.

III. Results and Discussion

There were 683 students enrolled in the six engineering courses (Table I). Tables II-IV show Likert-scale questions which the participants were asked on the pre-exam, post-exam, and end-of-quarter surveys. The five-point responses of 1 – *Not at all*, 2 – *Slightly*, 3 – *Moderately*, *4 – Significantly*, *5 – To a great extent* were associated with the respective numeric values for purposes of reporting averages (μ) and standard deviations (σ) as indicative measures of students' general perceptions. In Tables II-IV we report these measures (μ, σ) for each course, as well as for the aggregate population (all courses combined). In the text we quote only the aggregate values. For select survey questions the concrete distributions of Likert-scale responses are presented using bar charts further below.

TABLE I. Overview of courses and oral exam design parameters

	MAE 8[1]	**ECE 65**[2]	**ECE 35**[3]	**MAE 30A**[4]	**MAE 131B**[5]	**ECE 144**[6]
Enrollment	198	165	152	100	45	23
Level	Lower div.	Lower div.	Lower div.	Lower div.	Upper div.	Upper div.
IA support*	4 TAs	2 TAs, 2Ts	2 TAs, 6 Ts	1 TA, 2 Rs	1 TA	4 TAs
№ oral exams	1	2	3	3	1	1
Examinees†	100%	100%	100%	100%	100%	100%
Exam duration	10 min	15 min	15 min	15-20 min	15-20 min	10 min
Exam weight‡	5%	5% (×2)	3% (×3)	0% (×2), 4%	1%	7.5%
Questions†‡	HW-based	Independent	Independent	Writ.-exam based	Writ.-exam based	Independent

[1] MATLAB Programming for Engineering Analysis; [2] Components and Circuits Laboratory; [3] Introduction to Analog Design; [4] Statics and Introduction to Dynamics; [5] Fundamentals of Solid Mechanics II; [6] LabVIEW Programming: Design and Applications. * Number of teaching assistants (TA), tutors (T), and readers (R), normalized to 10 hrs/week each; † Percentage of enrolled students assessed per oral exam; ‡ Percentage of the total grade associated with each oral exam; †‡ Homework based, written-exam based, lab based, or neither (independent).

Pre-exam survey. At the beginning of the academic term in all the courses the majority (88.5%) of the respondents expressed little (48.3%) to no (40.2%) prior exposure to oral exams (not shown in Table II). Oral exams in each course were expected by students to contribute moderately to academic integrity ($\mu = 3.27$). Likewise, the students felt that oral exams will moderately help them to master the material in their courses or provide them extra incentive to do so ($\mu = 3.04$), and similarly help them to improve their technical speaking skills ($\mu = 3.08$). The sentiment that oral exams will likely cause them undue stress was strong among participants in all sections ($\mu = 3.68$). This is perhaps unsurprising given the general lack of student familiarity with oral exams expressed in the pre-exam survey. Student concern over examiner bias was moderate overall ($\mu = 2.74$).

Post-exam survey. As for the pre-exam survey, students' average responses on the majority of post-exam survey questions did not vary substantially from course to course (Table III). Students noted that they prepared for the oral exam somewhat differently in comparison to a written exam ($\mu = 2.62$). Such preparation was noted to have moderately improved their understanding of the subject matter ($\mu = 3.23$). Respondents found that the oral exams required a moderately higher level of conceptual understanding compared to written exams ($\mu = 3.01$). They also felt the oral exams have considerably helped them identify concepts they struggle with ($\mu = 3.36$). The participants thought the examiner treated them respectfully and fairly, to a great extent ($\mu = 4.72$). Moreover, they felt strongly that the examiner cared about their learning in the course ($\mu = 4.54$). The respondents finally expressed that they were able to overcome nervousness during the oral exam rather effectively ($\mu = 3.79$).

End-of-quarter survey. Oral exams were noted by respondents to have contributed moderately to significantly to the academic integrity in the course ($\mu = 3.67$; Table IV). Students expressed that oral exams noticeably helped, or incentivized them to master the subject material ($\mu = 3.22$), and similarly had a positive influence on their approaches to learning ($\mu = 3.16$). Oral exams were further indicated to have moderately increased student motivation to learn ($\mu = 3.16$), and similarly contributed to improving their oral communication skills ($\mu = 3.38$). Perceptions of bias were overall rather low ($\mu = 1.45$), far below the level of concern expressed in the pre-exam survey. Students found the oral exams to be rather fair and accommodating ($\mu = 3.86$). Still, the oral exams were noted by the respondents to have caused them slight to moderate undue stress ($\mu = 2.51$). Notwithstanding, the oral exams were largely seen by students as developing their ability to cope with nervousness to an appreciable extent ($\mu = 2.61$). The opinion that oral exams were beneficial in the remote environment was encouragingly strong ($\mu = 3.59$). Even once instruction is back on campus, the oral exams would, according to students, continue to be beneficial, though to a somewhat lesser extent ($\mu = 3.20$). Finally, the participants expressed moderate preference for oral exams over written exams ($\mu = 3.05$).

A more resolved look into students' perceptions and their evolution is offered in Fig. 1, showing distributions of participant responses on select questions posed on the pre-exam, post-exam, and end-of-quarter surveys. The impression

TABLE II. Pre-exam survey. μ: mean (σ: standard deviation)

	MAE 8	**ECE 65**	**ECE 35**	**MAE 30A**	**MAE 131B**	**ECE 144**	**Agg.†**
Do you believe oral exams will contribute positively to the academic integrity of a course?	2.98 (1.07)	3.52 (1.06)	3.31 (1.03)	3.30 (0.98)	3.07 (1.02)	N/A	3.27 (1.06)
Do you believe that having oral exams in a course will help you master the subject material better or provide extra incentive to do so?	2.82 (1.09)	3.11 (1.22)	3.06 (1.02)	3.17 (1.00)	3.14 (0.97)	N/A	3.04 (1.11)
Do you feel oral exams will help you improve your technical speaking skills?	2.86 (1.15)	3.23 (1.14)	3.08 (1.16)	3.11 (1.12)	3.14 (0.99)	N/A	3.08 (1.13)
Do you worry about oral exams because they will cause you undue stress?	3.91 (1.09)	3.43 (1.34)	3.49 (1.12)	3.97 (0.91)	3.72 (1.18)	N/A	3.68 (1.19)
Do you worry about oral exams because they will be subject to bias from the person conducting the exam?	2.83 (1.23)	2.88 (1.35)	2.27 (1.22)	2.83 (1.27)	2.53 (1.38)	N/A	2.74 (1.30)

Coding: 1 = *Not at all*, 2 = *Slightly*, 3 = *Moderately*, *4 = Significantly*, *5 = To a great extent*. Survey response rates: 62.1% (MAE 8), 92.7% (ECE 65), 42.8% (ECE 35), 66.0% (MAE 30A), 95.6% (MAE 131). * In ECE 144, the pre-exam survey was not administered. † Aggregate statistics (all responses combined).

TABLE III. Post-exam survey. μ: mean (σ: standard deviation)

	MAE 8	**ECE 65**	**ECE 35**	**MAE 30A**	**MAE 131B**	**ECE 144**	**Agg.***
Did you prepare differently for the oral exam compared to a written exam?	2.96 (1.26)	2.61 (1.28)	2.58 (1.23)	2.14 (1.08)	2.15 (0.92)	1.92 (1.08)	2.62 (1.24)
Do you feel that preparing for the oral exam improved your understanding of the subject matter?	3.26 (1.16)	3.55 (1.18)	3.17 (1.27)	2.68 (1.21)	3.15 (1.22)	3.25 (1.22)	3.23 (1.21)
Do you feel the oral exam requires a higher level of conceptual understanding compared to the written exams?	3.08 (1.27)	2.92 (1.23)	3.30 (1.20)	3.18 (0.96)	3.27 (1.34)	2.67 (1.37)	3.10 (1.24)
Do you feel that taking the oral exam helped you realize which concepts you still struggle with?	3.16 (1.27)	3.27 (1.34)	3.70 (1.18)	3.59 (0.96)	3.38 (1.13)	3.58 (1.00)	3.36 (1.23)
Do you feel the examiner treated you respectfully and fairly?	4.69 (0.50)	4.76 (0.52)	4.55 (0.75)	4.68 (0.57)	4.92 (0.39)	4.83 (0.58)	4.72 (0.56)
Do you feel the examiner cared about your learning in the course?	4.41 (0.85)	4.81 (0.47)	4.41 (0.86)	4.64 (0.58)	4.85 (0.37)	4.92 (0.29)	4.54 (0.75)
Were you able to effectively overcome nervousness during the oral exam?	3.94 (1.01)	3.82 (0.94)	3.51 (1.15)	3.82 (1.26)	3.88 (0.86)	3.17 (1.19)	3.79 (1.05)

Survey response rates: 51.0% (MAE 8), 27.0% (ECE 65), 31.7% (ECE 35), 22.0% (MAE 30A), 57.8% (MAE 131B), 52.17% (ECE 144).
* The aggregate μ and σ represent the weighted mean and standard deviation, computed using course-specific weights equal to $1/n$, where n is the number of oral exams administered in a course (see Table I).

that oral exams benefit academic integrity in the course was shared among many students both at the beginning of the term and at its conclusion (Fig. 1a), with the sentiment appearing to have grown stronger following students' experiences with oral exams. It may be that the students perceived oral exams as less practical to cheat on due to the adaptive, probing nature of examination and the element of unpredictableness. Furthermore, oral exams provide assessors a means to identify possible "unexplained" discrepancies between a student's understanding as demonstrated on their written exam work or homework, and that demonstrated on their oral exams. Students may, therefore, view oral exams as an additional security measure protecting written assessments in the course. While such deterrents to cheating may be useful in curbing academic integrity violations practically, it is expected that the increased perception among students that cheating is limited has power in itself to positively impact academic integrity, for students are generally less inclined to cheat when confidence in the fairness of evaluation is high [20], [21], [22], [23].

Concerns over oral exams causing undue stress and being subject to examiner bias are well documented in the literature on oral assessment [1], [3], [7], [8], [10], [13], [19]. In most of our courses, mock oral exams were organized to familiarize students with expectations and acclimate them to the dialogic testing environment, which we believe contributed to the near 180-degree flip in the distribution of perceptions about undue

TABLE IV. End-of-quarter survey. μ: mean (σ: standard deviation)

	MAE 8*	**ECE 65***	**ECE 35**	**MAE 30A**	**MAE 131B***	**ECE 144**	**Agg.**
Do you feel the oral exam(s) contributed positively to academic integrity in the course?	N/A	N/A	3.46 (1.41)	3.73 (0.80)	N/A	4.25 (1.06)	3.67 (1.24)
Did the oral exam(s) help you master the subject material better or provide extra incentive to do so? Did they contribute positively to your learning in the course?	N/A	N/A	3.30 (1.22)	2.80 (0.77)	N/A	3.50 (1.00)	3.22 (1.10)
Did the oral exam(s) influence your approach to learning in a positive way?	N/A	N/A	3.16 (1.26)	3.07 (0.88)	N/A	3.25 (1.22)	3.16 (1.15)
Did the oral exam(s) increase your motivation to learn?	N/A	N/A	3.24 (1.30)	2.87 (0.92)	N/A	3.25 (0.87)	3.16 (1.13)
Do you feel that the oral exam(s) helped improve your technical speaking skills?	N/A	N/A	3.08 (1.30)	3.60 (0.91)	N/A	4.00 (0.95)	3.38 (1.19)
Do you believe that there was inappropriate bias from the person conducting the exam?	N/A	N/A	1.51 (1.17)	1.67 (0.98)	N/A	1.00 (0.00)	1.45 (1.01)
Did you find oral exam(s) to be fair and accommodating to you?	N/A	N/A	3.73 (1.10)	3.80 (1.08)	N/A	4.33 (0.49)	3.86 (1.01)
Did the oral exams cause you undue stress?	N/A	N/A	2.50 (1.32)	2.53 (1.19)	N/A	2.50 (1.24)	2.51 (1.25)
Did the oral exam(s) help you with how to better deal with nervousness?	N/A	N/A	2.35 (1.32)	2.80 (0.94)	N/A	3.17 (0.83)	2.61 (1.18)
Do you feel it is beneficial to have oral exam(s) for this course when it is taught remotely?	N/A	N/A	3.57 (1.44)	3.20 (0.86)	N/A	4.18 (1.25)	3.59 (1.30)
Do you feel it would be beneficial to have oral exam(s) if this course were taught in-person?	N/A	N/A	3.14 (1.55)	2.67 (1.05)	N/A	4.08 (1.24)	3.20 (1.44)
Do you prefer oral exams over written exams?	N/A	N/A	3.49 (1.45)	1.87 (1.30)	N/A	3.17 (1.59)	3.05 (1.56)

Survey response rates: 25.5% (ECE 35), 15.0% (MAE 30A), 52.17% (ECE 144). * In MAE 8, ECE 65, and MAE 131B, the end-of-quarter surveys were not administered or had response rates below 5%.

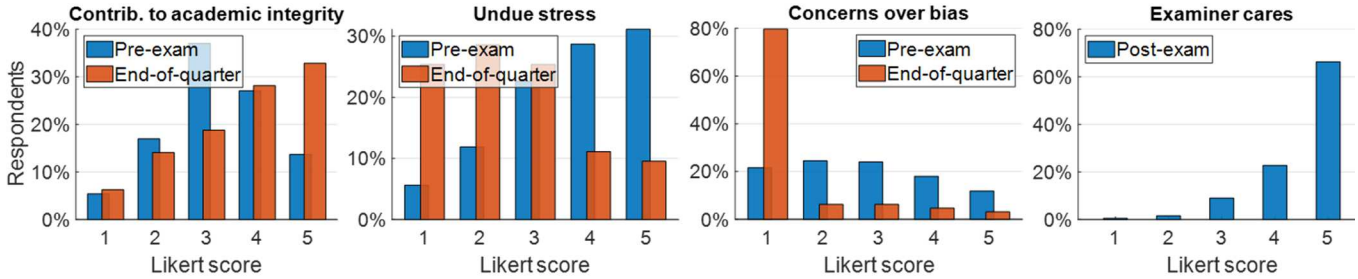

Fig. 1. Distributions of aggregated students' perceptions for select questions from the pre-exam, post-exam, and end-of-quarter surveys (see Tables II-IV).

stress between the beginning of the quarter and its end (Fig. 1b). Furthermore, the fairly uniform distribution of concerns about bias ranging from no concern whatsoever to intense worry, as observed at the beginning of the course, was radically skewed by the end of the term (Fig. 1c), with 80% of students expressing zero concerns at that point. We ascribe the favorable results in part to our development of oral exam rubrics designed to help minimize subjectivity, and to our training of the instructional assistants in matters of oral assessment. Our instructional assistants were involved in the administration and grading of the oral exams (Table I) in order to tackle the challenge of scalability in large classes, and we have taken precaution to minimize inter-assessor reliability through mock exercises and standardization of assessment practices and scoring. Leveraging teaching assistants (TAs) and tutors alike allowed us to realize oral exams in courses with enrollments as high as 145-200 students (MAE 8, ECE 65, ECE 35) and to conduct two (ECE 65) and even three (ECE 35, MAE 30A) oral exams within a 10-week academic term (Table I). We expect the inclusion of TAs and tutors in the oral assessment process and increased personal interaction with students in large classes has positively impacted students' motivation, engagement, and learning in the course. We also surmise that such interaction and engagement has positively contributed to students' desire to excel with integrity. Improved learning and competence after all imply reduced urge to cheat out of necessity [24], [25], [26]. The fact that students were overwhelmingly of the opinion that their examiner cared about their success in the course (Fig. 1d) and treated them respectfully and fairly (Table III) only speaks further to the sense of support which oral exams may engender in students [21], [27], [28], [29]. The increased closeness and exchange with the instructor and the instructional team may similarly enkindle in students an enhanced desire for sincerity and appreciation for authentic scholarship [30], [31], [32].

IV. Conclusions and Future Work

We have incorporated oral exams in six large-enrollment engineering courses in order to promote student engagement and uphold academic integrity. Students' perceptions were surveyed and their analysis indicates that oral exams were largely welcomed and benefited students' learning and course experience. Our future work will focus on exploring improvements to oral exam design and on seeking ways to more advantageously leverage the assessment modality to promote conceptual mastery, increased engagement, and professional growth in students. This will involve demographic data analysis and correlation studies to identify opportunities to evolve oral exams so as to best meet educational objectives while equitably catering to a diverse population of engineering undergraduates. It will involve a closer investigation into the social, affective side of oral exams as well, specifically, their capacity to promote quality student-instructional team interactions, build trust, foster relationships, incentivize learning, positively shape students' study habits, and improve self-efficacy and communication competence. Students' experiences of stress due to oral exams will hence need to be analyzed in more detail to determine to what degree stress acts as an activating versus a deactivating agent [33], and how it correlates with student performance and other variables across different student groups. Further investigation will similarly be necessary to gauge the extent to which oral exams may benefit academic integrity through strengthening students' sense of connection with community and appreciation of its principles, promoting social responsibility, contributing to students' character development, and empowering students to engage in original thought and to take pride in their own work. If corresponding virtues are sufficiently developed in students, they can be expected to feel a strong disinclination to cheat [30], [31], [32]. The potential of oral exams to inform the instructor's pedagogy and course (re)design will likewise be explored, along with opportunities that oral exams open to instructional assistants to advance their evaluative judgement skills and enhance their awareness of diversity, equity, and implicit bias.

Our early results presented in this work-in-progress paper suggest that oral exams can be a valuable instructional addition when campuses reopen. We have demonstrated that oral examination can be effectively adapted for large-enrollment engineering courses by leveraging instructional assistants while simultaneously addressing concerns over subjectivity and bias. We thus hope our work will encourage broader adoption of oral exams in engineering education, where student enrollment and class sizes have been trending upwards [34], [35]. Our ongoing work is also expected to have implications for distance and blended learning, where establishing and maintaining student-faculty and student-instructional assistant connections can be of great benefit to the students [36], [37].

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