Using Oral Assessments to Improve Student Learning Gains

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Abstract

Oral assessments provide various perceived benefits, such as improving students' technical speaking skills, probing their conceptual understanding, positively contributing to academic integrity, increasing motivation to learn, and offering a venue for students to show competency by verbally explaining the problem solutions. Compared to these perceived benefits, their effectiveness in increasing learning gains has been less explored through quantitative measurements. In this paper, we provide the results of our pilot study designed to assess the potential effect of oral exams on improving student learning. In this study, students were randomly assigned into two groups. The first group participated in the oral assessment administered early in the term, and the second group participated in the one administered close to the end of the term. The oral exam questions were based on two Take-home (TH) tests consisting of circuit design questions assigned to students a few days before each oral exam. Although all students submitted the TH tests, only students in the corresponding groups participated in the follow-up oral assessments. All students also took a written midterm exam before the first TH test and a final exam at the end of the term. The written midterm and final exam grades are used to measure the effect of oral assessments and the time of intervention on student learning. Our study findings reveal that, although the final exam was a challenging test with a lower class average compared to the midterm exam, students who completed their oral assessments early in the term experienced a smaller drop in their grades compared to those who participated in the oral assessment near the end of the term. This result suggests that oral assessments could have a positive impact on student learning gains, and the timing of these interventions affects those benefits. The standard deviations of the midterm and final exam grades in both groups were also compared to each other. For the student group who received the intervention early on, the standard deviation of the grades reduced from 29.1% on the midterm exam to 20.6% on the final exam. The standard deviation of the grades for the other student group changed from 27.1% on the midterm exam to 22.8% on the final exam. The relatively large difference in the performances of students in the early intervention group decreased at the end of the term. The data suggests that oral assessments could have a positive impact on reducing the achievement gap among students. In this paper, we will also report students' perceptions of the oral assessments and the extent to which they found these assessments useful to their learning and their confidence in themselves and their abilities.

Introduction

This literature review will contextualize the present study through a review of scholarship on oral assessments and learning by teaching.

Oral Assessments

U.S. undergraduate institutions predominantly depend on traditional written exams for assessments. Oral assessments, specifically one-on-one interrogations of a student by a member of the instructional staff, have existed as alternatives. However, their use has been limited, typically because of considerations regarding scalability, reliability, and student anxiety towards the novelty of such an assessment [1], [2], [3], [4], [5]. Nevertheless, they have also been shown to potentially promote important learning benefits. In several studies, attempts have been made to implement oral assessments in various undergraduate courses, ranging from Engineering to Mathematics courses, and some were conducted over periods of a few semesters [1], [2], [3], [4], [6], [7], [8], [9], [10]. These studies reported the positive effects of oral exams on improving the grades of at-risk students [6], [11] and improving students' motivation to learn and confidence in themselves [7], [12]. This study aims to corroborate previous data gathered on the implementation of oral assessments in undergraduate academics.

Prior studies have focused on different aspects of the implementation of oral assessments. These include students' emotional reactions during and after the assessment, impacts on academic integrity, and the difference in grading workloads between traditional and oral assessments [1], [2], [9], [10]. Preliminary results indicate positive effects on students' experience of a course. For example, while oral assessments may initially induce anxiety due to students' unfamiliarity with them, students, post-exam, believed that oral assessments had been more comfortable experiences than were anticipated [9], [13]. Studies also show that students who took an oral assessment spent significantly more time studying than students who took a written exam [2], [10]. This may be due to the idea that anticipating a one-on-one conversation with an instructor encourages students to understand course material more in-depth to avoid embarrassment, thereby taking more accountability for their learning, as mentioned by a student in a study by Boedigheimer et al. [10]. Studies have also shown that students' ability to generalize learned concepts and apply them to novel situations also improves, which is important to developing students' problem-solving repertoire. One study found that the general learning environment is also enhanced whereby instructors' close interaction with students allow them to better pinpoint where weaknesses in student learning of course content lie [7].

Other benefits of oral assessments are that they may better reflect professional situations that students will encounter after graduating, such as job interviews where they must verbally communicate ideas [4]. In this sense, oral exams may add depth to the range of communication skills acquired by undergraduates [3]. They can also provide the opportunity for increased inclusivity in the assessment process. A study showed that students with disabilities were more likely to prefer oral exams to written exams [4].

Finally, oral assessments may offer an additional dimension related to academic integrity. Some studies experimented with this assessment approach during the COVID-19 pandemic to improve students' online learning experience, specifically as it related to ensuring academic integrity and students' perceptions of academic fairness in the course [1], [14]. Similar considerations may become relevant as new technologies like chatGPT become more pervasive.

Learning by teaching

As an approach in which a student is asked to explain a concept, oral assessment bears some similarity to the idea of "learning by teaching." This concept has been studied since the 1970s [15], initially for language learning but later also in STEM [16]. Generally, these studies have reported benefits for the student in the tutor role that range from positive effects on attitudes, engagement, and confidence to improvements in their own academic performance [15], [16], [17]. These gains are suggested to derive from the fact that teaching affords opportunities to activate important learning processes, such as self-reflection and lowered resistance to change.

A study by Fiorella and Mayer aimed to further disentangle the relative effects of teaching activity, i.e., the gains from the actual acts of teaching, versus teaching expectancy, i.e., the gains from knowing that one will need to teach in the future and preparing for it [18]. Their work investigated this by comparing three groups of students: one that only prepared but did not teach, one that prepared and did teach, and one control group. They found that immediate comprehension gains were observed for both groups that had prepared to teach. However, the group that actually taught significantly outperformed both other groups when the evaluation test was given with a one-week delay. This points to the fact that both preparing for and actually teaching are important ingredients for persistent and deeper learning gains. Relating these findings back to oral assessments, it would suggest that both preparing for the oral assessment and actually participating in it may each have important contributions to students' learning.

Methods

In this study, approved by the Institute of Review Board (IRB) at the University of California San Diego, oral exams were integrated into ECE 65 (Components and Circuits Lab), a lower-division core circuits course offered in the Electrical and Computer Engineering (ECE) Department. ECE 65 is the second circuit course in the sequence of circuit classes in the ECE department. In this course, students learn about operational amplifiers and functional circuits built using them, diodes and diode waveform shaping circuits, BJT and MOSFET transistors, and the design and operation of the transistor amplifier circuits. The course is designed in a flipped classroom format where students watch pre-recorded lecture videos and respond to a reading quiz before attending each lecture. During the lecture, students practice solving circuit problems and discuss their thought processes with their peers. ECE 65 has 3-hour weekly lab sessions in addition to the standard 150-minute lectures per week. In the lab, students simulate, build, and

test the circuits they study in the lecture. The course is offered every quarter and during the summer. This study was implemented in the Fall 2021 offering of the course, with 61 of the enrolled students participating in it.

As part of the course, two Take-home (TH) tests with design questions were introduced to expand on and enhance the understanding of the topics covered in the course. These exams were conducted after an early in-person written midterm and before the in-person written final exam. Once the students completed their Take-home test solutions, they submitted their written work to Gradescope, the platform used for collecting and grading the course assignments. Following the Gradescope submission, about half of the students were asked to participate in an oral assessment to explain their thought processes for their solutions to the design problems of the TH test. To manage the workload of administering the oral exams, students were randomly divided into two groups using the Canvas Learning Management System. The first group, referred to as the Oral Assessment 1 (OA1) group, took an oral exam following the first TH test. The second group, referred to as the Oral Assessment 2 (OA2) group, participated in an oral exam after the second TH test. Table 1 displays the demographics of these two student groups who participated in the study.

Each oral exam was conducted via Zoom in a 15-minute long one-on-one interview format. The Professor or a Teaching Assistant (TA) asked students probing questions related to the TH test during the oral exam. Students answered questions such as “How does changing the collector and emitter resistor values affect the mode of operation of the BJT in your designed circuit?” or “How does selecting a drain resistor value different from yours in a common-source amplifier affect the maximum signal swing?.” The performance of the students in the oral exam was evaluated using a three-point rubric shared with them before the exams. Students received full credit of 3 out of 3 when they demonstrated a good understanding of the topics and answered the probing questions correctly. If they had some misconceptions or mistakes in their explanations, they received 2 out of 3. Students who were less familiar with the subject received 1 out of 3 on the oral exam. Constructive feedback and guidance were provided to the students who did not receive full credit. The oral exams were scheduled over a span of four days after the deadline for each TH test.

While the students in the OA1 group participated in this exam, the OA2 group was asked to participate in a peer review activity, where each student evaluated the TH test submissions of three of their peers. Similarly, the OA1 group participated in a peer review activity when the OA2 group took their oral assessments. Students were provided a rubric for this purpose. All written TH test submissions were graded independently by Teaching Assistants, separate from oral exam and peer review grades. The peer review grades were only meant to be used as formative feedback for students.

The weight of each course component towards the total course grade was as follows. Each TH test counted for 10%, the midterm exam for 15%, each OA or Peer Review for 5%, the labs for 10%, the reading quizzes for 5%, and the final exam for 35% of the total grade.

Table 1. Demographics of students enrolled in ECE 65 - Fall 2021 and participating in the study.

	Number of Students	3rd year	4th year
Oral Assessment 1 Group	30	9	21
Oral Assessment 2 Group	31	7	24
All Participants	61	16	45

To collect feedback from students, surveys were administered following oral assessments 1 and 2. Two open-ended questions aimed to capture students' perspectives on the strengths and areas for improvement in the oral assessment and peer review activity. In addition to these open-ended queries, Likert scale questions were included. Students were asked to rate, on a scale of 1-5 (with "strongly agree" corresponding to 5 and "strongly disagree" corresponding to 1), whether interactions with the assessor during the oral assessment positively influenced their confidence in themselves and their abilities as well as their understanding of the subject matter. Furthermore, in the survey after the second oral assessment at the end of the quarter, students were prompted to report their stress levels during the written and oral assessments using a 1-10 scale, with 1 corresponding to low stress and 10 corresponding to high stress.

Results

We performed the Student t-test to compare the midterm grades and the Mann-Whitney U test to compare the final exam grades between Oral Assessment 1 and 2 groups and found no statistically significant difference ($p = 0.41$ for the midterm exam and $p = 0.37$ for the final exam.) The distribution of the midterm and final exam grades for students in the Oral Assessment 1 and 2 groups is shown in Figure 1.

We compared the Take-home (TH) tests 1 and 2 grades for the Oral Assessment 1 and 2 groups using the Mann-Whitney U tests, and no statistically significant difference was found ($p = 0.61$ for TH test 1 and $p = 0.47$ for TH test 2.) The statistics of grades on different assessments for the Oral Assessment 1 and 2 groups are presented in Table 1. The standard deviation of grades for the OA1 students has decreased from 29.1 in the midterm exam to 20.6 in the final exam. The corresponding change was smaller for OA2 students. The standard deviation of

grades for the OA2 students has decreased from 27.1 in the midterm exam to 22.8 in the final exam. The final exam was a challenging test, and the average grades decreased for both groups from the midterm to the final exam. However, the decrease in the grade was smaller for OA1 students.

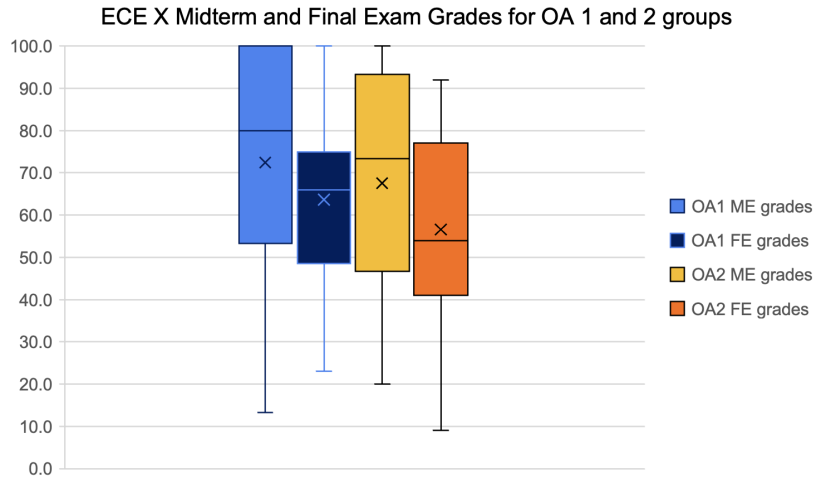

Figure 1. The normalized Midterm Exam (ME) and Final Exam (FE) grades for students in Oral Assessment 1 (OA1) and Oral Assessment 1 (OA2) groups.

Table 1. The statistics of grades on different assessments for students in OA1 and OA2 groups.

Exam Name	Student Group	Mean Grade	Median Grade	Standard Deviation
Midterm Exam	OA1	72.4	80.0	29.1
	OA2	67.5	73.3	27.1
Final Exam	OA1	63.7	66.0	20.6
	OA2	56.6	54.0	22.8
Take-home Test 1	OA1	79.6	85	21.1
	OA2	80.1	84	15.4
Take-home Test 2	OA1	93.6	98.9	13.8
	OA2	91.7	97.7	13

We used the Kruskal-Wallis test to compare the levels of agreement of OA1 and OA2 students with the statement, "Interactions with the assessor during the oral assessment positively contributed to my confidence in myself and my abilities". This question was included in the survey administered after oral assessment 2. The test showed that there was no significant

difference between the two groups (P = 0.595.) Students generally showed a strong consensus in favor of this statement. As shown in Figure 2, in the OA1 group, 78% of survey participants agreed or strongly agreed that the interactions during the OA increased their confidence in themselves and their abilities. This percentage was 70% for OA 2 students.

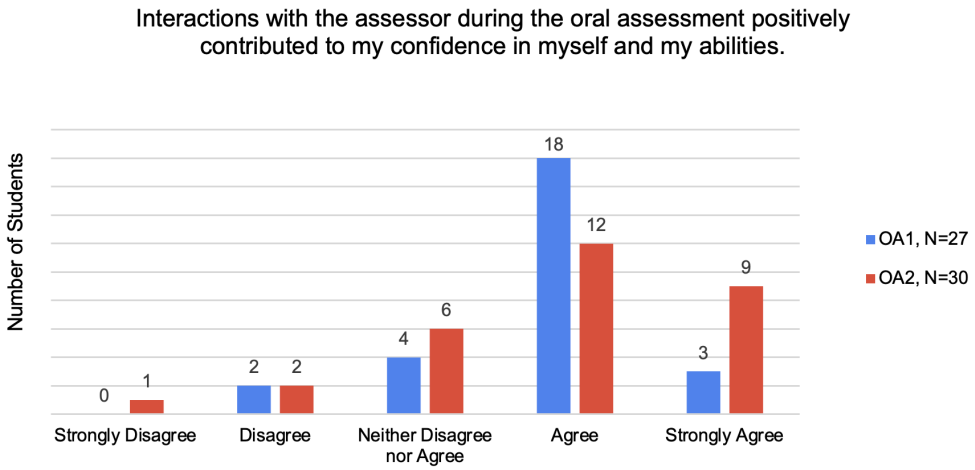

Figure 2. The agreement levels of students from OA1 and OA2 groups with the statement, “Interactions with the assessor during the oral assessment positively contributed to my confidence in myself and my abilities.”

In the survey after oral assessment 2, we also asked students to rate their agreement with the statement: ”The oral assessment increased my understanding of the subject matter”. We compared the level of agreement with this statement between OA1 and OA2 students using the Kruskal-Wallis test, and it was not statistically significant (P = 0.945). Figure 3 represents a comparison between the agreement levels of students from OA1 and OA2 with this statement. The OA1 students had an average agreement level of 3.9 out of 5, with 74% of the students agreeing or strongly agreeing with the statement. The OA2 students had an average agreement level of 3.8 out of 5, with 70% of the students agreeing or strongly agreeing with the statement.

In the survey administered after the second oral assessment, we asked all students to rate on a scale of 1 to 10, with 1 corresponding to low stress and 10 corresponding to high stress, how much stress the written exam has caused them in the course. To gather feedback about students' stress levels during the oral assessments, we asked the OA1 group to respond to a similar stress question but on the oral assessment in the survey after the first oral assessment and the OA2 group to respond to the same question in the survey after the second oral assessment. The results of the Kruskal-Wallis tests showed that while there was no significant difference between the two groups in their stress levels on the oral exam (p =0.153), there was a significant difference (p = 0.018) between the two groups in their stress levels on the written exam. OA1 students reported higher levels of stress during the written test. Figure 4 compares the reported stress levels of OA1 and OA2 students during the written exams and oral assessments in the course.

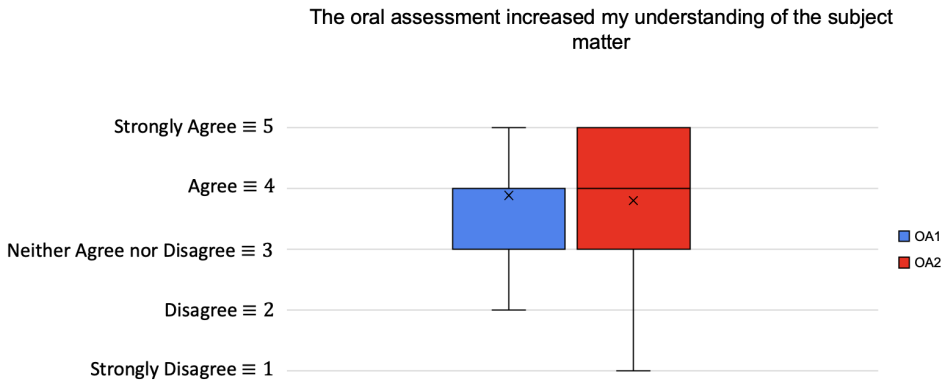

Figure 3. The agreement levels of students from OA1 and OA2 groups with the statement, "The oral assessment increased my understanding of the subject matter."

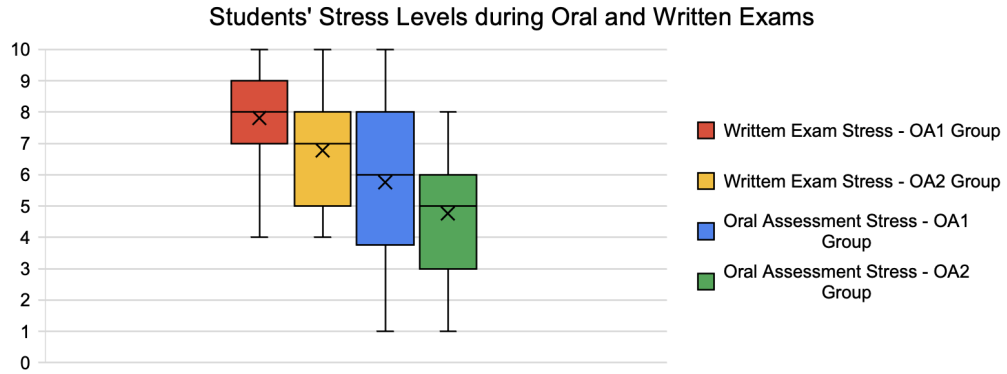

Figure 4. The OA1 and OA2 students' reported stress levels during the written and oral assessments.

All the feedback regarding the oral assessments for the free-response question was positive. Students mentioned several positive aspects of the oral assessment. They found it suitable to demonstrate their understanding of the materials. They also appreciated the engaging and positive interactions they had with the TAs during their oral tests. Additionally, students felt that these tests were effective in enhancing their understanding of the materials. One student mentioned that the oral assessment had prompted them to change their study strategy: [It mainly changed my study strategy because I had to focus on explaining the reasoning behind my work rather than just solving the problems mindlessly.] Compared to feedback about oral assessments, students had mixed feelings regarding the peer review activity. Some liked the peer review activity as they were able to see other students' thought processes and learn about other and sometimes more efficient ways to solve the problems. Other students found it stressful or not helpful to their learning either because it took them a long time to grade peer submissions or because they were unsure if their peers' answers were correct. One student wrote about their

experience of peer review activity and compared it to their experience of oral assessment: [If I have to compare between peer review and oral assessment, though oral assessment causes me more stress, I prefer the assessment more because I think that it helps me with my understanding more. In the assessment, I get to receive personalized and specific feedback from the teaching staff about my work.]

Discussion

This study aimed to investigate the potential impact of oral assessments on student learning gains in a core circuits course offered by the Department of Electrical and Computer Engineering at the University of California San Diego. The enrolled students split into two groups, OA1 and OA2. The students in the OA1 group took an oral assessment early in the quarter, while the students in the OA2 group took the assessment towards the end of the quarter. The results of our pilot study suggest several noteworthy findings regarding the effectiveness of oral exams and their timing, as well as students' perceptions of these assessments.

Our results indicate that students who completed their oral assessments early in the quarter experienced a smaller negative change in their grades compared to those who participated in the oral assessments closer to the end of the quarter. Considering the fact that the final exam was more challenging than the midterm exam, lower final exam grades do not necessarily imply a reduced overall learning gain. Thus, our findings suggest that oral assessments may have a positive impact on student learning gains, with the timing of these interventions playing a crucial role in realizing these benefits. The decrease in the standard deviation of grades, particularly notable in the group receiving the intervention early in the quarter (OA1 students), indicates a more consistent level of performance among students, potentially fostering a more equitable learning environment. These findings underscore the importance of oral assessments as an instructional tool in engineering education.

Comparing stress levels between the OA1 and OA2 groups, we observed that there was no significant difference in the oral assessment stress levels between the two groups, and the average oral assessment stress level was lower than the average written exam stress level. This aligns with previous research highlighting the potential for oral assessments to reduce test anxiety and promote a more positive assessment experience [19]. In ECE 65, the smaller weight of the oral assessments compared to the written midterm exam might have also played a role in this result. Unlike in oral assessments, there was a significant difference between the written stress levels reported by the OA1 and OA2 students. OA1 students reported higher stress levels during written exams.

Our analysis of responses to the Likert scale questions indicates that students generally showed a strong consensus regarding the positive impact of oral assessments on their confidence (74% of survey participants agreed with the positive effect) and understanding of the subject

matter (72% of survey participants agreed with the positive effect). Furthermore, data on students' perception of oral assessments, gathered through open-ended questions, provides valuable insights into their educational value. The overwhelmingly positive feedback from students regarding the oral assessments indicates that these assessments are perceived as beneficial tools for enhancing learning. Students appreciated the opportunity to demonstrate their understanding of the materials verbally, engage in positive interactions with the Teaching Assistants (TAs), and receive personalized feedback on their work. These findings are consistent with those reported in another study examining students' perceptions of oral assessments within engineering courses [20].

Future Work

In the future, we will explore several avenues to further enhance the effectiveness of oral assessments in engineering education. One key aspect we will investigate is the potential impact of increasing the grade contribution of oral assessments on student learning gains and their confidence in their abilities. Additionally, we will closely monitor the stress levels of students during oral assessments, particularly when the grade contribution of these assessments has been increased. We will investigate whether there is a correlation between exam stress levels and course performance. By systematically examining these factors, our future research aims to provide evidence-based insights into optimizing the design and implementation of oral assessments to promote student learning in engineering courses.

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References:

[1] M. Sabin, K. H. Jin, and A. Smith, "Oral Exams in Shift to Remote Learning," in *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, in SIGCSE '21. New York, NY, USA: Association for Computing Machinery, Mar. 2021, pp. 666–672. doi: 10.1145/3408877.3432511.

[2] P. Ohmann, "An Assessment of Oral Exams in Introductory CS," in *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, Minneapolis MN USA: ACM, Feb. 2019, pp. 613–619. doi: 10.1145/3287324.3287489.

[3] A. Akimov and M. Malin, "When old becomes new: a case study of oral examination as an online assessment tool," *Assess. Eval. High. Educ.*, vol. 45, no. 8, pp. 1205–1221, Nov. 2020, doi: 10.1080/02602938.2020.1730301.

[4] M. Huxham, F. Campbell, and J. Westwood, "Oral versus written assessments: a test of student performance and attitudes," *Assess. Eval. High. Educ.*, vol. 37, no. 1, pp. 125–136, Feb. 2012, doi: 10.1080/02602938.2010.515012.

[5] D. Kang *et al.*, "Providing an Oral Examination as an Authentic Assessment in a Large Section, Undergraduate Diversity Class," *Int. J. Scholarsh. Teach. Learn.*, vol. 13, no. 2, May 2019, doi: 10.20429/ijsotl.2019.130210.

[6] M. A. Nelson, "Oral Assessments: Improving Retention, Grades, and Understanding," *PRIMUS*, vol. 21, no. 1, pp. 47–61, Dec. 2010, doi: 10.1080/10511970902869176.

[7] Y. Zhao, "Impact of Oral Exams on a Thermodynamics Course Performance," presented at the 2018 ASEE Zone IV Conference, Mar. 2018. Accessed: Jan. 05, 2024. [Online]. Available: https://peer.asee.org/impact-of-oral-exams-on-a-thermodynamics-course-performance

[8] I. Gent, B. Johnston, and P. Prosser, "Thinking on Your Feet in Undergraduate Computer Science: a constructivist approach to developing and assessing critical thinking," *Teach. High. Educ.*, vol. 4, no. 4, pp. 511–522, Oct. 1999, doi: 10.1080/1356251990040407.

[9] D. Kang *et al.*, "Providing an Oral Examination as an Authentic Assessment in a Large Section, Undergraduate Diversity Class," *Int. J. Scholarsh. Teach. Learn.*, vol. 13, no. 2, 2019, Accessed: Jan. 05, 2024. [Online]. Available: https://eric.ed.gov/?id=EJ1218283

[10] Boedigheimer, M. Ghrist, Peterson, and Kallemyn, "Individual Oral Exams in Mathematics Courses: 10 Years of Experience at the Air Force Academy," *PRIMUS*, vol. 25, Feb. 2015, doi: 10.1080/10511970.2014.906008.

[11] C. Schurgers *et al.*, "Oral Assessments as an Early Intervention Strategy," presented at the 2023 ASEE Annual Conference & Exposition, Jun. 2023. Accessed: Dec. 10, 2023. [Online]. Available: https://peer.asee.org/oral-assessments-as-an-early-intervention-strategy

[12] N. Delson *et al.*, "Can Oral Exams Increase Student Performance and Motivation?," in *2022 ASEE Annual Conference & Exposition*, Minneapolis, 2022.

[13] K. P. Rouser, "Oral Assessments of Student Learning in Undergraduate Aerospace Propulsion and Power Courses," *J. Eng. Gas Turbines Power*, vol. 139, no. 124701, Sep. 2017, doi: 10.1115/1.4037577.

[14] D. E. Gardner and A. N. Giordano, "The Challenges and Value of Undergraduate Oral Exams in the Physical Chemistry Classroom: A Useful Tool in the Assessment Toolbox," *J. Chem. Educ.*, vol. 100, no. 5, pp. 1705–1709, May 2023, doi: 10.1021/acs.jchemed.3c00011.

[15] S. Frager and C. Stern, "Learning by Teaching," 2024.

[16] A. R. Carberry, "A Review of Learning-by-Teaching for Engineering Educators," 2012.

[17] Y. (Joy) Li, Z. Li, and C. Zhang, "Learning-by-Teaching in CS Education: A Systematic Review," presented at the Hawaii International Conference on System Sciences, 2022. doi: 10.24251/HICSS.2022.120.

[18] L. Fiorella and R. E. Mayer, "The relative benefits of learning by teaching and teaching expectancy," *Contemp. Educ. Psychol.*, vol. 38, no. 4, pp. 281–288, Oct. 2013, doi:

10.1016/j.cedpsych.2013.06.001.
[19] A. Phan, M. Kim, M. Lubarda, C. Schurgers, and H. Qi, “Impact of Perceived Stress during Oral Examination on Student Performance Outcomes,” in *2023 ASEE Annual Conference & Exposition Proceedings*, Baltimore , Maryland: ASEE Conferences, Jun. 2023, p. 43487. doi: 10.18260/1-2--43487.
[20] S. Baghdadchi, A. Phan, C. Sandoval, H. Qi, M. Lubarda, and N. Delson, “Student perceptions of oral exams in undergraduate engineering classes and implications for effective oral exam design”.