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Integration of Nearpod to Promote Active Learning in Undergraduate-level Thermodynamics Course

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Abstract

This instructional initiative in the format of a full paper highlights compelling teaching techniques with the integration of a web-based technology tool, 'Nearpod', in undergraduate-level, non-coding, engineering course 'Thermodynamics'. This course integrates engineering concepts with quantitative problem-solving techniques. This study prioritizes evaluating students' experiences with Nearpod rather than analyzing its impact on academic grades.

An active learning classroom is essential in creating a dynamic learning environment that infuses engagement and interaction, self-assessment and reflection, autonomy and motivation among students [1], [2]. Integrating technology into education is an effective way to create active learning environments. In this study, Nearpod was employed as a platform to promote various aspects of active learning in the classroom and enhance students' learning experiences in two sections of Thermodynamics course, involving a total of seventy-two students.

Previous studies integrating Nearpod into various disciplines and educational settings have demonstrated its effectiveness as an active learning platform [3], [4], [5]. This tool offers interactive and game-based features for versatile applications, enabling diverse outcomes and experiences across courses. Unlike previous investigation, this study explains how this tool was integrated into both in-class and out-of-class learning while also shares the instructor's perspective on its impact on teaching effectiveness. The primary objective of this study is to cultivate an active learning environment that facilitates a supportive learning process for the students. Additionally, it aims to develop a deeper understanding of student perspectives among instructors and assist them in adapting their instructional delivery accordingly.

In this study, interactive activity questions integrated into this tool were projected during class to obtain responses from the students. Additionally, these Nearpod activities were made available to the students as post-lecture resources in a student-paced mode. Thereby, this study integrates Nearpod both as in-class learning activities and post-lecture resource, creating a comprehensive learning approach.

The student-reported outcomes were collected through robust feedback from students based on several target questions. Additionally, a supplementary mid-term survey was administered by the institution's Center for Teaching and Learning Excellence (CTLE). Nearly 90% of the surveyed students perceived Nearpod as providing a supportive learning environment. According to this study, comparative analysis features like poll and Time-to-Climb helped students gauge their progress in the course and motivated them to strive for improvement. The collaborate board feature allowed students to view diverse responses from their peers, broadening their perspectives on problem-solving techniques. Additionally, instructors can identify learning gaps and tailor their communication strategies to convey concepts more effectively. These references collectively demonstrate the effectiveness of Nearpod as an educational tool in this course.

Introduction

Student-centered methods are considered superior to teacher-dominated practices as learning thrives in an active, engaged environment rather than a passive one [1]. Studies suggest an active learning platform encourages a self-directed learning approach, and it improves concept of application, critical thinking, collaborative mindset, motivation, attention, autonomy and retention of knowledge [1], [2], [3], [4], [5]. According to these studies, the benefits of active learning extend to providing students with multiple pathways for learning and applying knowledge. It enables formative feedback that enhances student learning, fosters collaboration that sparks motivation and builds collegial relationships, and allows instructors to better understand students' perspectives. Formative feedback plays a crucial role in active learning by offering timely, actionable insights that help students improve their understanding and performance [6]. Peer-teaching fosters greater motivation and autonomy compared to traditional learning methods, where students rely entirely on teachers. It enables students to explore diverse perspectives and engage more actively in the learning process [1]. While they have distinct characteristics, accountability and self-assessment often work in tandem to enhance performance and foster growth [7]. An active learning environment can be cultivated by providing students with a platform to participate in meaningful activities. Use of technology and game-based learning is an effective way to promote active learning, particularly in engineering courses [2], [8].

Overview of Nearpod

Nearpod is a multi-featured student response system (SRS) which can easily be used in a BYOD (bring-your-own-device) system. Since students can access their mobile devices during class, Nearpod becomes an easily accessible tool for classroom activities. Instructors can use the classroom computer connected to the available Wi-Fi network to display the Nearpod interface and student responses. It is a free web-based tool for teachers and students, with additional benefits available through institutional subscriptions.

Nearpod provides two teaching modes: "Live Participation" mode and "Student-Paced" mode. In the live mode, students are required to complete activities within a pre-set timeframe, while the student-paced mode allows them to work at their own time and pace. Nearpod offers a variety of interactive and gamified features, such as poll, collaborative board and Time-to-Climb, including other basic features, such as quiz, open-ended question, etc.

Canvas serves as the primary learning management system (LMS) for students at our institution. While Canvas provides traditional assessment tool like classic quizzes with basic assessment features (e.g. multiple choice, essay, etc.), Nearpod expands the pedagogical toolkit with more diverse and interactive features and dynamic user interface. Nearpod's compelling elements, such as vibrant visuals, audio, and avatars, enhance student engagement. The novelty of using a distinct and more interactive platform alongside the ubiquitous Canvas can stimulate student interest and participation. Specific examples of Nearpod features (poll, collaborative board and Time-to-Climb) used in my classroom are detailed in the "Examples of Nearpod Activities Conducted" section.

Nearpod can be utilized in various ways to achieve diverse learning outcomes. One approach is for instructors to use Nearpod to teach and present course topics by uploading PowerPoint or PDF slides, along with other media, and seamlessly integrating interactive features into their lectures. Another approach is to use Nearpod as a platform for students to practice problems in an interactive way, rather than in a traditional method, which can serve as class activity. In both cases, students

join the Nearpod platform using their own internet-connected devices and submit their responses directly.
Nearpod has previously been recognized as an effective tool for promoting active learning incorporated in a variety of courses, such as language [9], [10], [11], [12], nursing [13], [14], math and science [15], [16], business [17], engineering and computer science [18], [19], with diverse representation spanning from secondary to post-secondary education. This tool has also been applied in online platforms, demonstrating its versatility across diverse educational settings [10], [15], [20].

Process and Vision of the Study

In this study, Nearpod was utilized for in-class activities, while traditional PowerPoint presentations were used for lectures due to the absence of built-in animation features in Nearpod. Canvas LMS was used for course management. Conventional paper-based methods were utilized for administering weekly quizzes and exams. During class, interactive activity questions embedded in Nearpod were projected to gather student responses. Additionally, these Nearpod activities were made available to students in a student-paced mode as post-lecture resources, allowing them to practice further and receive automated feedback from the system. This approach integrates Nearpod as both an in-class learning tool and an out-of-class resource, offering a comprehensive learning experience that distinguishes this study from previous studies on Nearpod. This study also highlights instructor's perspectives and explores how Nearpod can assist educators in evaluating their teaching effectiveness. Additionally, this study shares valuable techniques to maximize the students' experiences with Nearpod. The integration of Nearpod and the evaluation of its effectiveness can be approached in various ways, as the experience with this tool differs across courses. This makes it a valuable study to demonstrate its application and benefits in different educational contexts.
As the learning outcomes of this study, I aim to address the following questions:

- According to students, are the features of Nearpod effective in creating an enjoyable learning environment in the classroom and an engaging active learning platform to practice problem solving?
- How can Nearpod support student learning outside the classroom?
- How can Nearpod help instructors better understand students' needs?

As students are the primary users and target group in this study, I utilized students' comprehensive feedback and explicit comments as the principal avenue for assessing Nearpod's effectiveness in enhancing their learning experience. Results from the students' survey indicate that a significant majority of students enjoyed using Nearpod and experienced a supportive learning environment through this tool.
This study focuses on leveraging Nearpod to create an engaging and interactive learning environment rather than assessing its impact on conventional grading metrics. Hence, this study does not encompass a comparison of student grades with and without Nearpod usage.

Course Description

I integrated Nearpod into two sections of an upper-level undergraduate Thermodynamics lecture course during the Fall 2024 semester. Section 1 and section 2 comprised of 35 and 37 students,

respectively, resulting in a total enrollment of 72 students. The sections consisted of both general and military students, with approximately 30% female representation. This course is held three times a week, with each session lasting 50 minutes. This 3-credit course is available to sophomore through senior-level students and is primarily offered to aerospace and mechanical engineering majors, and open to students from other departments seeking an engineering elective. This course may serve as a prerequisite for advanced courses in heat transfer, propulsion, or energy systems.
The course emphasizes problem-solving skills, applying theoretical principles to real-world engineering scenarios. The microlearning approach was employed to divide complex problems into smaller, manageable segments, facilitating their integration into the interactive features of Nearpod.

Examples of Nearpod Activities Conducted

There were around 15 "Live" sessions conducted for in-class activities, after which each was converted to the "Student-Paced" mode and shared with students as a post-lecture resource, allowing them to practice at their own convenience. These activities were conducted either in between class lectures after reviewing a topic or throughout an entire class period following the completion of one or more chapters in the previous lectures. During live sessions, instructors can pause activity between questions for discussion.
Students used predetermined nicknames to maintain anonymity, as instructor's Nearpod interface was displayed on the projector, allowing everyone to view each other's responses. As an instructor, I was aware of the identities behind the nicknames so that I could accurately assign points and assess each student's performance.
Among the various interactive features offered by Nearpod, I have highlighted the ones most frequently used in my classroom. Figures 1 to 3 illustrate the feature displays from the instructor's Nearpod interface during the live class activity. I project the instructor interface to my students, allowing them to view overall class performance and evaluate their own progress. Certain answer options, such as "Still confused", "Can't figure out", "Need more time to solve", were intentionally included in multiple-choice questions to assess students' ability to genuinely solve the problem and to identify any potential learning gaps. These answer options enable students to communicate their needs rather than simply selecting a random answer option.
Activity Feature 1 (**Figure 1**) → **Poll**: It is a comparative analysis feature. It provides the performance statistics of students for each question included in the activity session. This activity feature employs multiple-choice questions. The example in **Figure 1** shows that 33.3% of students selected option A, 33.3% chose option B, and 33.3% chose option C. Since all students answered the question, option D received 0%. I included options A to C, while option D was automatically generated. Nearpod has an option to include an image in any question. I included the T-ν diagram to this question.

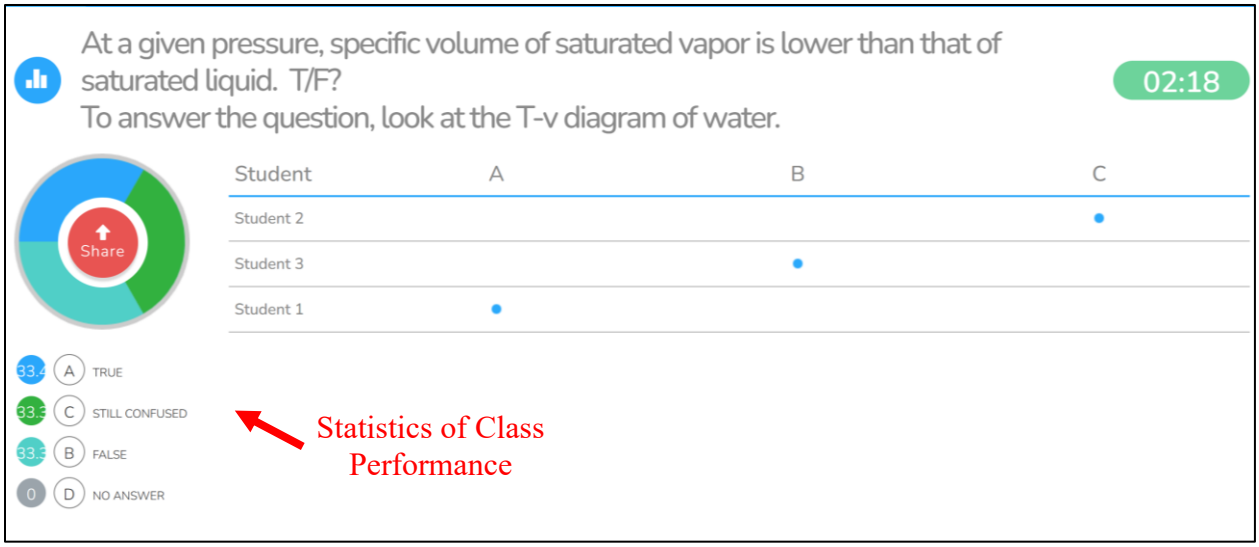


Figure 1: Nearpod "Poll" Feature.

Activity Feature 2 (**Figure 2**) → **Time-to-Climb**: This is a speed-based game. It is a comparative analysis feature. It provides the performance statistics of students for the entire question set included in the activity session. Students earn additional points for correct answers based on how quickly they answer them. This features a leaderboard that displays students' ranking. To enhance engagement, it includes funny avatars for students to represent themselves and background music to create an enjoyable atmosphere. This activity feature employs multiple-choice questions. I have primarily used this feature for quiz and exam review sessions. The example in **Figure 2** has two interfaces displayed on instructor's Nearpod interface. The overall leaderboard on the left indicates that, out of 5 questions, Student 1 answered 2 correctly, while Students 2 and 3 each answered 1 correctly. The interface on the right shows that for question 5 specifically, 2 students selected the correct option C, while 1 student chose the incorrect option B. The projected point system is autogenerated. **Figure 2A** in the Appendix illustrates the Time-to-Climb feature's theme setting, avatars and activity display as they appear on instructor and student Nearpod interfaces.

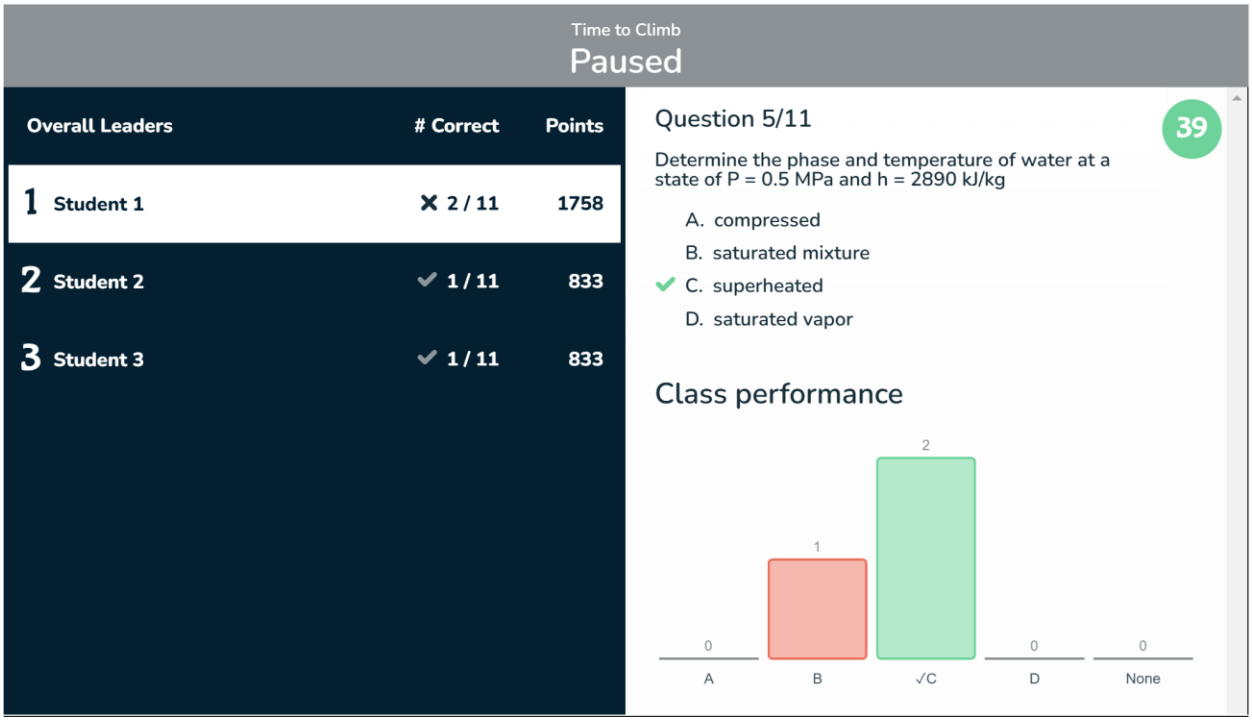


Figure 2: Nearpod "Time-to-Climb" Feature- Teacher's Display

Activity Feature 3 (**Figure 3**) → **Collaborative Board**: This feature serves as a platform for sharing answers, allowing students to respond by either typing and posting their answers or uploading images of their work. Both the instructor and students can provide comments on each other's submissions. Additionally, students have the option to delete their responses if they upload an incorrect answer or image. This feature is well-suited for descriptive responses and numerical problems involving multiple steps. I encourage students to review their peers' contributions and identify the most appealing responses. Students are prompted to react to posts they find particularly interesting and to leave comments if they have any questions or need clarification on the content presented. Again, the use of anonymous usernames fosters a more open and comfortable environment for students to share their contributions.

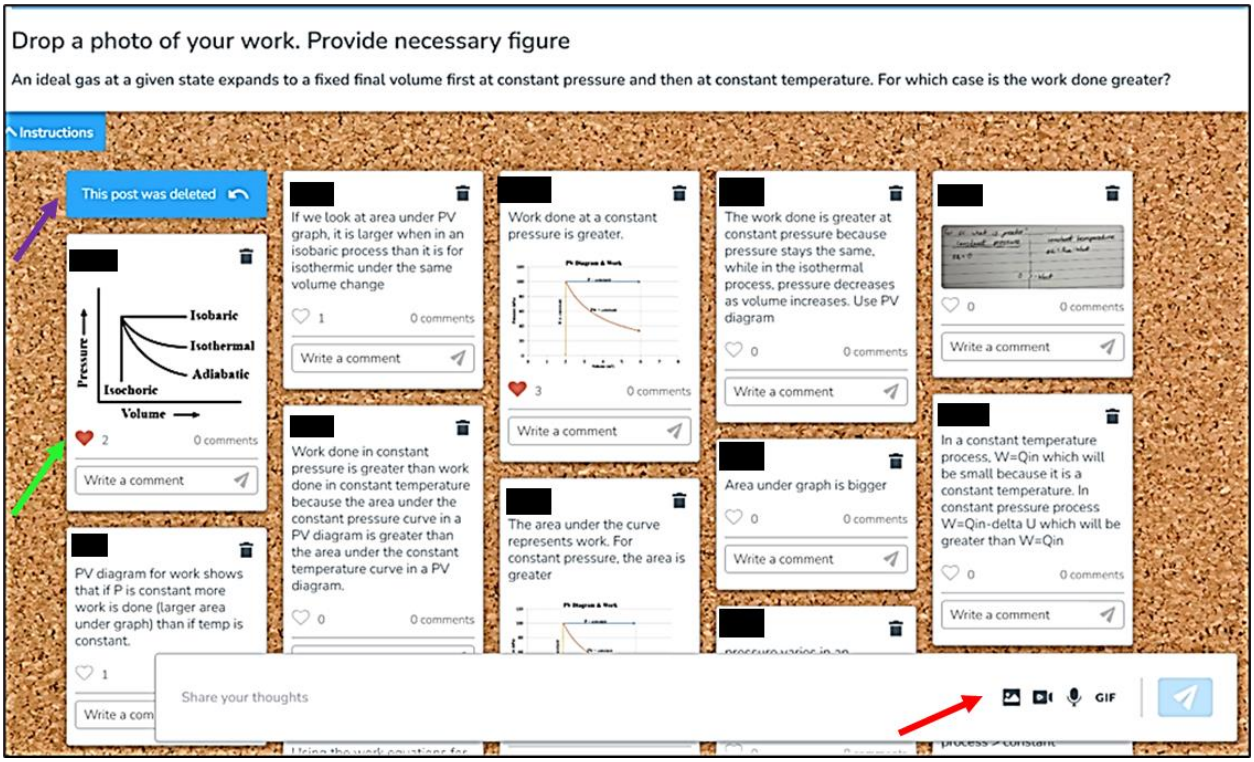


Figure 3: Nearpod "Collaborative Board" Feature. The red arrow represents the option to add media; the green arrow represents the option to react and respond to posts; and the purple arrow represents the option to delete posts. The black box is used to hide students' names.

Features 1 and 2 are ideal for live sessions, as they enable the instructor to compare students' performance in real time. For student-paced mode, I convert these features into a simple quiz format, another feature available in Nearpod. Feature 3, on the other hand, is suitable for both live and student-paced modes. However, responses posted during live sessions are not saved. To address this, I occasionally used Feature 3 in student-paced mode during in-class sessions, ensuring that the posted answers were saved and accessible for students to review later.

Nearpod generates detailed post-session reports for both teaching modes, enabling instructors to evaluate students' participation and performance on each activity question, including the class average. These reports can be downloaded and shared with students via email. The Example of a post-session report is shown in **Figure 6A** in Appendix. After each live session, I review the reports and award bonus points to students for their participation in the activity.

Student-Reported Outcomes

To evaluate the effectiveness of Nearpod in fostering active learning and enhancing students' learning experiences, students were invited to complete a comprehensive survey. A total of 56 students participated in the survey, with 25 from Section 1 and 31 from Section 2. The survey was conducted anonymously, and students were given the option to opt out.

The survey included the following five target questions (Q1 to Q5), designed to capture students' views on how Nearpod supports various interconnected elements (E1 to E4) of active learning.

Additionally, two more target questions (Q6 and Q7) were included to evaluate students' overall perspectives on Nearpod's effectiveness in fostering a supportive learning system.
Table 1 below outlines the targeted questions (Q) and expected elements (E) of active learning to be incorporated into the classroom. **Table 2** summarizes **s**tudents' responses to these targeted questions. **Table 3** presents the verbatim responses from students to the supplementary questions regarding Nearpod, highlighting how active learning elements were incorporated into their learning experience using Nearpod.

Table 1: Targeted Questions Posed to Students and Expected Active Learning Elements.

Q1:	The features of Nearpod greatly contribute to students' engagement in the class.
Q2:	Nearpod supports the practice of peer-teaching among the students.
Q3:	Using Nearpod allows me to comprehend my performance relative to the class.
Q4:	Nearpod brings an element of fun to the learning environment in the classroom.
Q5:	Nearpod has positively influenced my retention of classroom information.
Q6:	Nearpod greatly supports my learning experience.
Q7:	Do you want to continue using Nearpod?
E1:	Engagement and Enjoyment.
E2:	Peer-Teaching and Collaboration.
E3:	Accountability and Motivation through Self-Assessment or Self-Reflection.
E4:	Knowledge Retention.

The student survey result summarized in **Table 2** reveals a strong positive notion towards Nearpod's role in promoting active learning. A significant majority of the students indicated (through strong agreement or agreement), that Nearpod effectively boosts engagement, scope for self-assessment, enjoyment and retention of knowledge within the course (Q1-3-4-5). Nearly 90% of students perceived Nearpod as a supportive learning tool (Q6) and above 90% expressed interest for its continued use (Q7). The relatively low student support for Q2 may indicate a lack of clarity among students regarding the concept and importance of peer-teaching. Another possible explanation for this perception is that students skilled in problem-solving might not realize they were indirectly teaching their peers who found problem-solving challenging. In the future, I will educate students thoroughly on the concept and importance of peer-teaching, as well as other essential elements of active learning.

Table 2: Summary of student survey result involving 56 students. ***Total #*** *represents the number of respondents in section 1+ section 2. The histogram displays the* ***% distribution of responses in a sequence from strongly agree to strongly disagree*** *and the bar highlighted in* ***red*** *represents the maximum number of responses.* ***In Favor (%)*** *represents the % of student number in favor (strongly agree+ agree).*

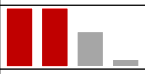
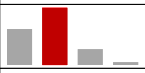
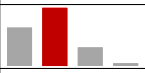
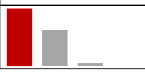
		Strongly Agree	**Agree**	**Neutral**	**Disgaree**	**Strongly Disgaree**	**Histogram (%)**	**In Favor (%)**
Q1 Engagement	Total #	8+13= **21**	14+15= **29**	3+2= **5**	0+1= **1**	**0**		
	%	37.5	51.785714	8.928571	1.785714	0		89.285714
Q2 Peer-Teaching	Total #	6+13= **19**	7+12= **19**	8+4= **12**	3+1= **4**	1+1= **2**		
	%	33.92857143	33.928571	21.42857	7.142857	3.5714286		67.857143
Q3 Self-Assessment	Total #	10+8= **10**	14+14= **28**	1+7= **8**	0+2= **2**	**0**		
	%	32.14285714	50	14.28571	3.571429	0		82.142857
Q4 Emotional Resonance	Total #	5+13= **18**	13+14= **27**	6+3= **9**	1+1= **2**	**0**		
	%	32.14285714	48.214286	16.07143	3.571429	0		80.357143
Q5 Retention	Total #	8+12= **20**	16+16= **32**	1+2= **3**	0+1= **1**	**0**		
	%	35.71428571	57.142857	5.357143	1.785714	0		92.857143
Q6 Support System	Total #	8+14= **22**	16+12= **28**	0+4= **4**	1+1= **2**	**0**		
	%	39.28571429	50	7.142857	3.571429	0		89.285714
Q7 Enthusiasm	Total #	13+18= **31**	11+9= **20**	1+2= **3**	0+1= **1**	0+1= **1**		
	%	55.35714286	35.714286	5.357143	1.785714	1.7857143		91.071429

Table 3: Students' Comments on Nearpod

Highlighted Active Learning Elements				Selected Students' Comments
E1	**E2**	**E3**	**E4**	
√	√	√	√	• Nearpod allows us a chance to quiz ourselves. In addition, seeing how others solved the problem has been a great help. The Nearpod posted after the lecture assist me to further solidify and retain my understanding. The Nearpod have been a great source of practice.
√	√	√		• It helps me with practice problems and collaborating with my peers, we all try to help each other in understanding the topics in class. It also shows me what I need help with and what I should study more.
√		√	√	• Nearpod supports my learning because I use them as study guides for tests and quizzes. They support my class engagement because I tend to be a shy student and prefer not to share my answers out loud. But with Nearpod, I am able to engage in class in a more comfortable way.
		√		• Having additional practice problems in class as well as immediate feedback (whether the answer or method used was right/wrong) helps me adjust and learn from my mistakes before assessments.
	√	√		• It helped me understand where I was relative to the class and understand approaches taken by peers.
	√	√		• It helped me to put what we went over in class into effect by pushing me to answer the questions on Nearpod. It also helped me to realize where I need to study, review, and helped me to realize that I am not the only one struggling with certain concepts.
√		√	√	• It allows me to have a safe environment where I can attempt questions, get them wrong and have no penalty for making the attempt, allowing me to really understand what I need to learn.
√		√		• A lot more fun than listening to a lecture, is more interactive and lets us all solve problems right there as a class. Also gives us all a second to try to understand the material before immediately jumping into more slides.
			√	• I appreciate the Nearpod being posted to Canvas after class. Additional practice/review problems before quizzes and exams are very helpful.
√		√		• It gives me instant feedback. I like this. Nearpod is a fun break from a regular lecture and allows us to work together.

The Center for Teaching & Learning Experience (CTLE) at my institution administered mid-semester evaluations for both of my class sections using different methods.

- Section 1: 20 Students completed an unsupervised mid-semester survey.
- Section 2: A CTLE representative conducted an in-class mid-semester feedback session with 36 students divided into 12 groups consisting of 3 students in each group.

It is important to note that this survey/session did not specifically address Nearpod or assess its effectiveness. Rather, it focused on evaluating the overall student experience in the course. In response to the following question posed to section 1, "What is working well in this class? What are the strengths of the class, and which aspects are having a positive impact on your learning?", more than half of the students explicitly identified Nearpod as the most beneficial aspect. When asked about the class strengths in section 2, 11 out of 12 groups ranked Nearpod as the top strength of the course. This strong endorsement across both sections highlights Nearpod's significant positive influence on the students' learning experience.

As a secondary avenue for evaluating Nearpod, CTLE observed multiple lectures. The CTLE observer employed the Classroom Observation Protocol for Undergraduate STEM (COPUS) for the observations. This method requires a trained observer to simultaneously monitor both student and faculty behaviors. COPUS focuses on identifying instructional and learning patterns throughout a class session, with data collected consistently every two-minutes [21].

The CTLE member observed lectures on diverse topics, which naturally led to differences in the expected levels of student engagement across the sessions. Despite this, **Figure 4** reveals classes utilizing Nearpod activity consistently showed an increase in the percentage of high engagement in the classroom, indicating an enhancement in students' attention and comprehension of course material [22].

Since both groups of students used same content, the difference in engagement levels between Nearpod and Non-Nearpod classes might not be substantial and may not always be captured by COPUS. An alternative method for assessing student engagement is through direct instructor observation and student feedback.

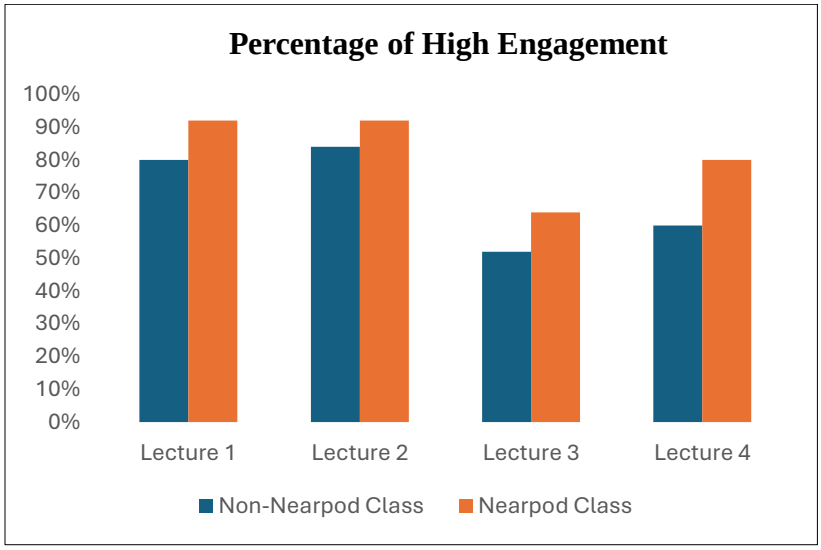


Figure 4: Impact of Nearpod on student engagement

Instructor-Reported Outcomes

One student cited, "I like Nearpod because the teacher can see how well the class understands a certain topic," and I completely agree with this remark.

Let's look at **Figure 1**. The example from the poll activity shown in Figure 1 indicates that one-third of the students answered incorrectly, while another third remains uncertain about the answer. This situation prompts the following actions:

- I analyze the learning gap and revisit the topic to clarify concepts.

- I ask both groups, who answer correctly and who answer incorrectly, to share their approaches to the question. Through a broader discussion, we then explore effective strategies for solving the question and identify common mistakes students make with similar problems. Often, I invite students who answer correctly to demonstrate their work on the whiteboard.

From the several positive impacts Nearpod had on my students, the most significant impacts that I take away from this experience are:

1. It helps me identify the performance gap and adjust my teaching approach. This provides an opportunity for self-evaluation and reflection among instructors. Additionally, the live teaching mode of Nearpod is highly effective to promote feedback intervention.

2. By observing their peers' work, students gain diverse perspectives on problem-solving (collaborative board in Figure 3). I have also sometimes learned innovative approaches from my students. Through live sessions that incorporate comparative analysis tools (Poll in Figure 1), students can evaluate their own performance and class standing, which inspires them to strive for improvement. This creates an opportunity for self-evaluation and reflection among students.

3. Nearpod's interactive and game-based features foster student excitement and connect them better with the learning materials, offering a fun time and break from the traditional lecture, such as Time-to-Climb in Figure 2. The fixed time limit allocated for each question encourages students to adopt a competitive mindset, pushing them to utilize their critical thinking skills effectively.

4. Students frequently asked if Nearpod activities would be accessible on Canvas. While participation was linked to bonus points and did not directly impact grades for non-participants, it helped incentivize students to improve their performance. The student-paced teaching mode allowed students to practice further and gave absent students an opportunity to catch up.

5. Allowing students to use a nick name during the live session and earn points for participation helped maximize the participation level.

Challenges and Suggestions from the Instructor's Perspective:

1. **Use of Nearpod in Different Courses:** Depending on the course, type of contents, and the desired outcomes, the use of Nearpod features, the design of activities, and the frequency of Nearpod use will vary. Instructors should carefully assess the use of suitable Nearpod

features for their course and how often students will use Nearpod in the classroom, as excessive use may lead to monotony.

- For instance, videos can be uploaded to Nearpod with questions embedded at specific intervals. While this feature may not be ideal for the types of problems I address in Thermodynamics, I plan to use it in a different course to encourage students to watch the entire video.

2. **Effort Needed:** Incorporating Nearpod for in-class activities requires additional preparation time for instructors to input questions into the platform. To streamline this process, I adapt to questions like quiz and exam for Nearpod use. For complex numerical problems, I segment them into smaller, more manageable components. The time investment may fluctuate depending on the specific Nearpod features utilized, the nature of the questions, and the course content. Once developed, these Nearpod activities can be reused and improved in subsequent semesters, maximizing the initial time investment.

3. **Grading Improvement:** Unlike this study, if improving student performance in terms of grades is the most desired outcome, instructors may need to mandate the use of Nearpod participation, while remaining flexible to accommodate occasional absences or lack of responsiveness [13].

4. **Post-session report generated in Nearpod:** This report provides the performance of individual student in individual questions (**Figure 6A**). Instructors can utilize this valuable Nearpod tool to monitor attendance and reach out to students who are absent or consistently underperform in the interactive Nearpod activities conducted during the class.

5. **Instructor's Nearpod Interface:** While students can view the Nearpod interface on their own devices, projecting the instructor's interface in the classroom during a live activity session provides students a chance to view the class performance and it helps students better connect with the learning activities.

6. **Quantitative Evidence of Engagement:** Conventional engagement measurement methods like COPUS may not always yield statistically significant differences between Nearpod and non-Nearpod classes for in-class activities, though significant distinctions may emerge when comparing Nearpod-based instruction to traditional PowerPoint lectures. However, without Nearpod, it is challenging for instructors to verify individual engagement, especially in larger classes, whereas Nearpod provides a clear number of active participants.
   - While quantitative evidence of engagement levels is necessary for academic publication, my personal observations as an instructor, completion rates of activity questions and student feedback strongly indicate that students particularly enjoyed Nearpod activities, especially when utilizing its interactive features.

Conclusion

I utilized the diverse multimodal features of Nearpod to design activities with questions that closely aligned with course content and future graded assignments. Students reported that the live

mode provided a unique platform to master course material by learning from peers, identifying knowledge gaps, and receiving formative feedback from the instructor. The student-paced mode, on the other hand, supported retrieval practice and reinforced knowledge retention. As an instructor, Nearpod enabled me to address student shortcomings and refine my teaching strategies effectively. By fostering active learning outcomes that are as impactful as final grades, this tool has proven to be an invaluable educational resource for this course.

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Appendix

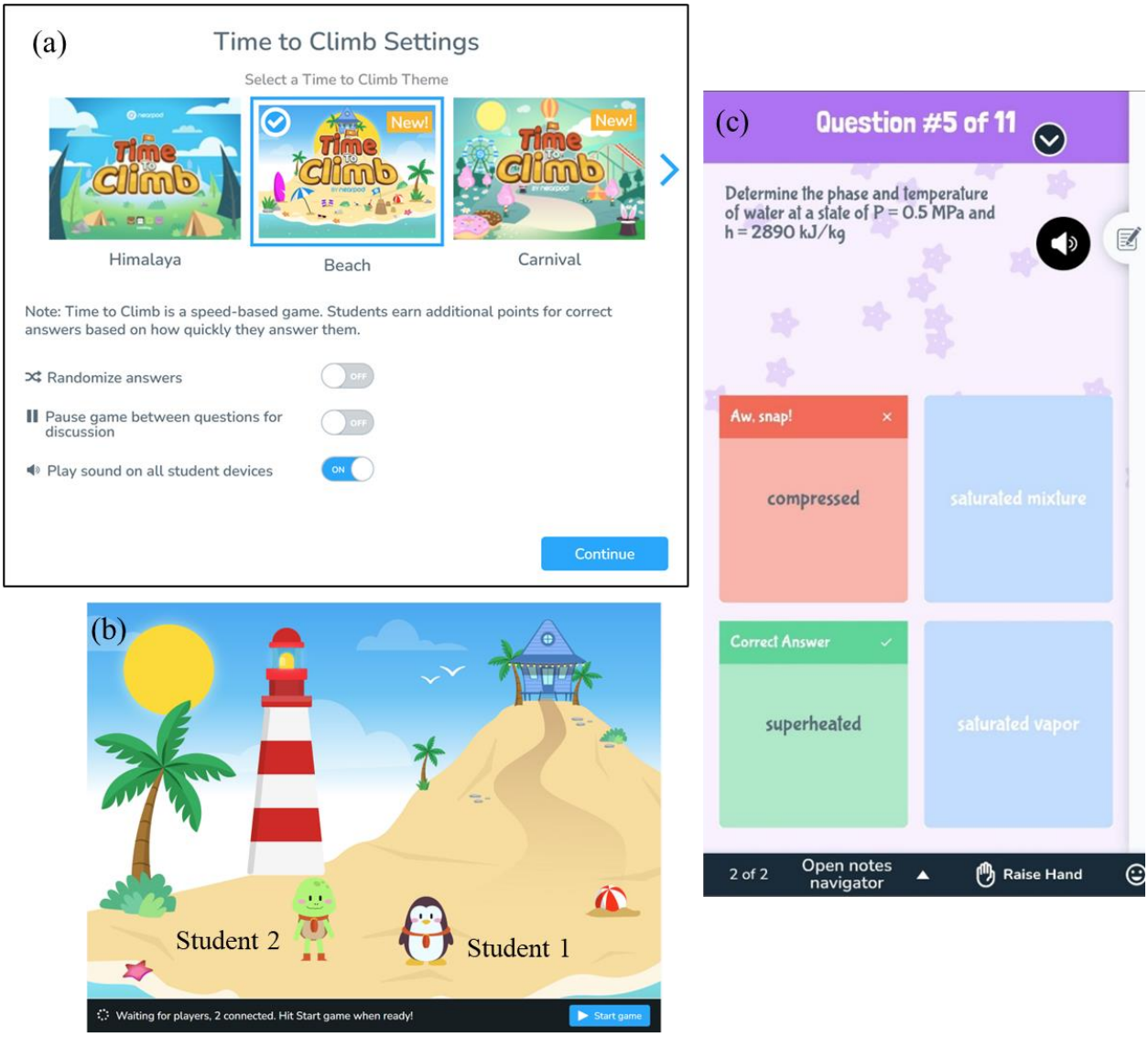

Figure 2A: Nearpod's "Time-to-Climb" Feature, (a) This feature offers various interactive themes such as Himalaya, Beach, Carnival, etc.; (b) Students' chosen avatars shown on instructor's interface; (c): Activity example on student's interface. It indicates that the student chose an incorrect option (red box), and the correct option is superheated (green box).

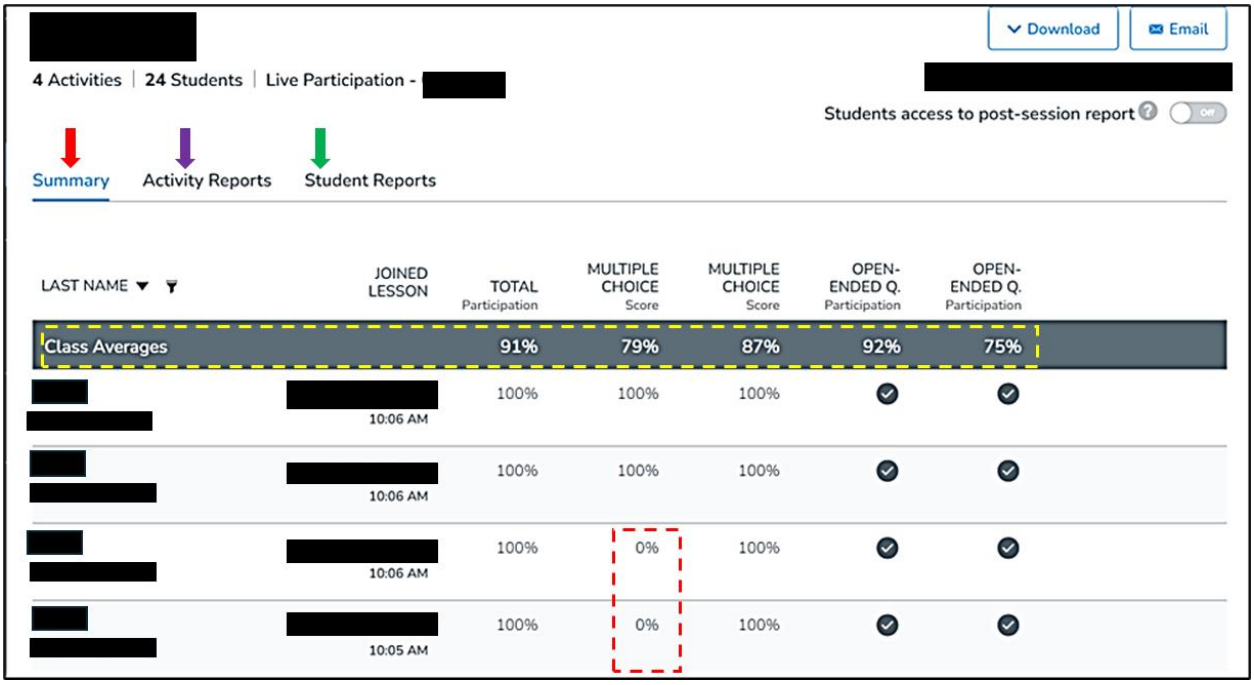

Figure 6A: Post-Session Report. Black bar is used to hide identifiable information. The red arrow represents the summary tab that includes the class performance in the entire activity session (the yellow dashed box). The purple arrow represents the activity reports tab that includes the class performance in the individual activity using a specific Nearpod feature. The green arrow represents the student reports tab that includes individual performance report of the student in the entire activity session which can be emailed to them for their review. The red dashed box shows that two students did not answer the multiple-choice question.

- **Additional Comments from Students about Nearpod:**
  - Allows us to focus on practice problems in a competitive way and encourages teamwork if problem is not known.
  - It helps reinforce concepts and allows for easy access to practice problems, along with being a medium through which I can collaborate, learn from , and teach my peers.
  - I think Nearpod is a great resource for studying as it provides collaborative practice problems that help know what we are proficient in and what we need more understanding in.
  - Nearpod has been a very useful study recourse to better prepare for tests. It also provides a creative and unique learning environment for the classroom.
  - Having practice problems is the best way for me to learn the material. Nearpod gives a structure to do many problems consecutively.
  - It kept me engaged and actually working on a problem with good feedback if most people get it wrong.
  - It gives me an opportunity to practice quiz/test level questions without the stress and importance of a test.
  - It allows me to be accountable for my work in trying to understand the material.
  - It allows me to work together with my classmates, while motivating us to complete in class activities.
  - It allows for class examples that are challenging yet allow me to learn better. I like that we can go in Nearpod after class and study in it.
  - It allows me to practice problems that are very applicable to the homework, quizzes, and exams. It has helped my grades by allowing me to practice problems.