KarmaCollab: A Communication Platform For Collaborative Learning

Damitu Robinson, University of California, Davis
Mr. Nicholas Hosein

Nicholas is a PhD candidate at the University of California Davis with a background in computer architecture, algorithms and machine learning. His current focus is advancing the electrical engineering curriculum at UC Davis to be more industry relevant in

Prof. Andre Knoesen, University of California, Davis

Andre Knoesen received his Ph.D. degree from the Georgia Institute of Technology, Atlanta, in 1987. He is currently a Professor in the Department of Electrical Engineering, University of California, Davis. He performs research in sensors and nonlinear o

Akash Kashyap

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Abstract

The COVID-19 pandemic has forced universities to transition to a fully online format, resulting in a renewed interest into how technology can aid learning while physically apart. While many courses can easily transition to video streaming, others such as STEM laboratory classes, require hands-on training, and as a result, experienced significant hurdles with the remote learning switch. In this paper, the impact of an internally developed smartphone application called KarmaCollab is evaluated alongside the incorporation of socialized teaching and course gamification. We will look at UC Davis Electrical and Computer Engineering laboratory courses and the impact KarmaCollab had on the online course format. The relationships between course grades, KarmaCollab app engagement, student self-reported sentiment via an end-of-quarter survey, and teaching staff interviews are presented to showcase interesting remote learning insights.

Introduction

The COVID-19 pandemic has forced universities to transition to a fully online format, resulting in a renewed interest into how technology can aid learning while physically apart. While many courses can easily transition to video streaming, others such as STEM laboratory classes, require hands-on training, and as a result, experienced significant hurdles with the remote learning switch. In this paper, the impact of an internally developed smartphone application called KarmaCollab is evaluated alongside the incorporation of socialized teaching and course gamification. We will look at UC Davis Electrical and Computer Engineering laboratory courses and the impact KarmaCollab had on the online course format. The relationships between course grades, KarmaCollab app engagement, student self-reported sentiment via an end-of-quarter survey, and teaching staff interviews are presented to showcase interesting remote learning insights.

At the start of 2020, university students, staff, and faculty faced the unforeseen challenge of transitioning to a fully online curriculum due to the COVID-19 shelter in place order. Although fully online course formats are nothing new, university courses are traditionally built around an in-person experience. One area that thrives from an in-person format is STEM laboratory courses. From chemical mixtures in a controlled lab setting to constructing circuits with the assistance of a laboratory Teaching Assistant (TA), STEM laboratory courses teach hands-on experience that students may not obtain elsewhere. Along with the lost opportunity to learn in-person, fully online courses have requirements such as reliable internet access, a suitable studying environment, and strong self-motivational skills. These factors make online learning particularly challenging.

Historically, online courses are a more affordable option for students looking to further their education. Before taking an online course, however, students must assess whether their skills are on par with the requirements of an online course. Such skills range from strong self-motivation to comfort navigating a computer. Transforming an in-person course to fit the standard of an online one can provide a jarring experience for students who are not mentally prepared for the transition as online lacks the level of socialization and intimacy compared to its in-person counterpart. To help navigate these challenges, online tutoring platforms (i.e. Chegg or Quizlet), chat group applications (i.e. Discord or Slack), and instructional platforms (i.e. Khan Academy) are all useful for supporting a remote learning environment. KarmaCollab was developed at the University of California, Davis (UC Davis) as an experimental platform to test new ways of utilizing technology to streamline social learning and advance the remote experience for students and staff in STEM courses.

Literature Review

Research is plentiful on the topic of integrating technology into the classroom. Pilgrim et al. discussed that using technology such as smartphone or web apps, provides educators the ability to engage students, foster higher-level thinking and develop problem-solving skills that align with today's technological society [1]. Brindley et al. furthers this discussion with work on creating collaborative learning groups in an online environment [2]. Their findings show a correlation between participation in small group collaboration and deeper learning, development of learning, and teamwork skills. Collaboration was found to create an increased sense of community for the learner, thus increasing satisfaction and retention. Sanders et al. brings up an interesting point that students often may not be equipped with an adequate level of readiness to collaborate in an online format and often see colleagues as rivals [3]. Building community is essential to establish, and with the help of online resources and instructional guidance, a healthy dynamic can be created in the remote classroom. The flipped method, also known as inverted learning, has been increasingly researched in STEM fields.

Flipped learning aims to shift direct instruction from the classroom to home, opening class time to flexible, interactive learning experiences. Karabulut-Ilgu et al. applied the flipped method to a transportation engineering course [4]. Students expressed a positive sentiment to the change, saying they enjoyed the flexibility, pacing and felt like they understood the material more at the end of the course. Blended learning is another method that combines the strength of face-to-face learning with online tools. Garrison and Kanuka et al proposes ways that blended learning can be used in higher education to enhance in-person learning with technology [5]. The KarmaCollab research presented here is fundamentally different than the prior work in that by creating our platform, from scratch, in-house, we afford a higher degree of flexibility on what collaborative learning theories can be tested in the classroom.

KarmaCollab Overview

University students have access to a smartphone and high-speed internet as part of an assumed requirement to participate at a university. Apps have entered the education space that helps students and teaching staff more efficiently disseminate information and streamline communication.

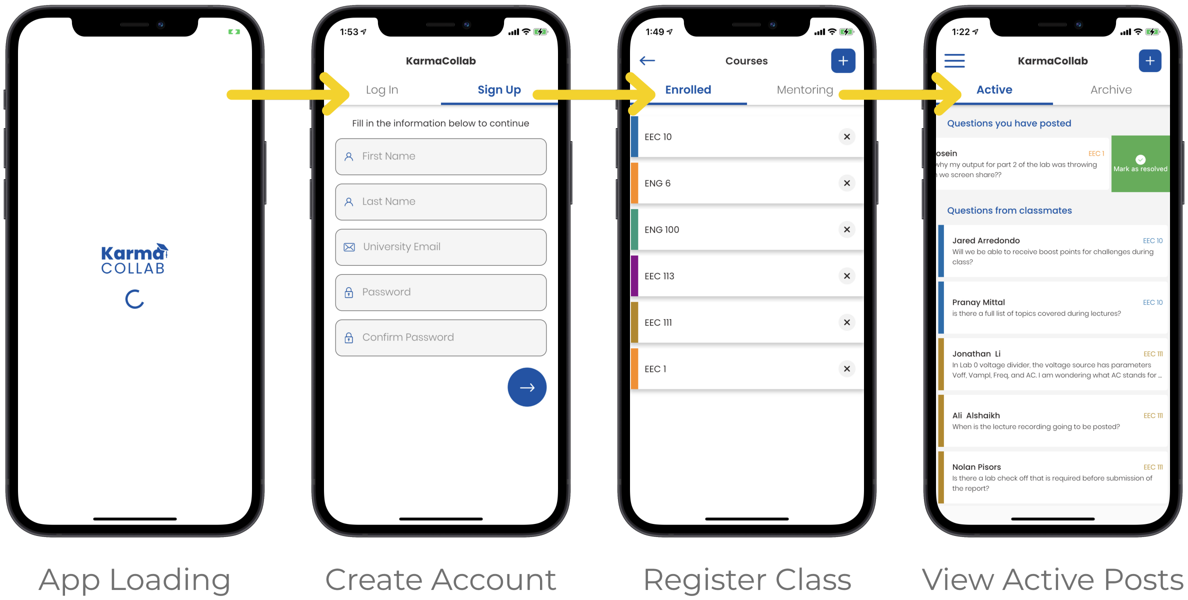

Figure 1: KarmaCollab onboarding of students.

This overlay of technology and education brings fresh opportunities for students to learn and faculty to teach. KarmaCollab is an experimental platform that allows us to analyze technology's effect on student learning and behavior. Figure 1 shows the onboarding process for students on KarmaCollab. They download the app, create an account using their university email, register for their classes, and contribute to the discussion.

KarmaCollab vs Other Platforms

KarmaCollab is an online platform designed to facilitate communication and collaboration between students and teaching assistants in a classroom setting. When compared to other similar platforms, KarmaCollab has key differences. Discord and Slack are platforms that shares in some of the online communication tools similar to KarmaCollab but unlike KarmaCollab, their range is limited to chat and voice communication. While both can be used for educational purposes, it is not specifically designed for that purpose like KarmaCollab. Additionally, Discord does not have the same level of integration with educational tools as KarmaCollab.

Chegg is an online tutoring platform that offers live chat, video chat, and an online whiteboard for students and tutors to collaborate. While it has some similar features to KarmaCollab, Chegg is primarily focused on one-on-one tutoring, whereas KarmaCollab is designed for group collaboration in a classroom setting. KarmaCollab offers features such as question and answer forums and centralized dashboards that allow multiple students and TAs to collaborate on course materials.

Overall, KarmaCollab stands out as a platform specifically designed for educational purposes, with a focus on facilitating collaboration between students and TAs in a classroom setting. It offers features such as real-time chat, question and answer forums, and a centralized dashboard for organizing and managing course materials. Its integration with educational tools and analytics capabilities also makes it a valuable resource for instructors looking to monitor and improve student engagement and performance.

Posting and Answering

KarmaCollab is intended to resemble a social media platform like Twitter and less similar to a group chat platform like Slack. The app keeps questions to a short life cycle, being posted, answered, and then migrated to the archive section of the app, where they expire after not being viewed for an extended time. Figure 1 shows the active post screen where questions and discussions from different courses are color-coded. Each post on KarmaCollab is its own dedicated space with text chat, image posting, and video room. Posts can be marked resolved by the question poster or expired if left untouched for a long time.

Instant Screen Share

Video chat has become a useful replacement for face-to-face discussion during remote learning. One of the issues faced with many video chat services (like Zoom) is that jumping on spontaneous calls can be overly complicated. It usually involves creating a call, sharing a link with participants via email, and scheduling a time to talk. With KarmaCollab, the expectation is that students that want to screen share or talk face to face over video could jump into a room in a matter of seconds. Figure 2 shows the flow of posting a question and joining the video room to screen share or talk.

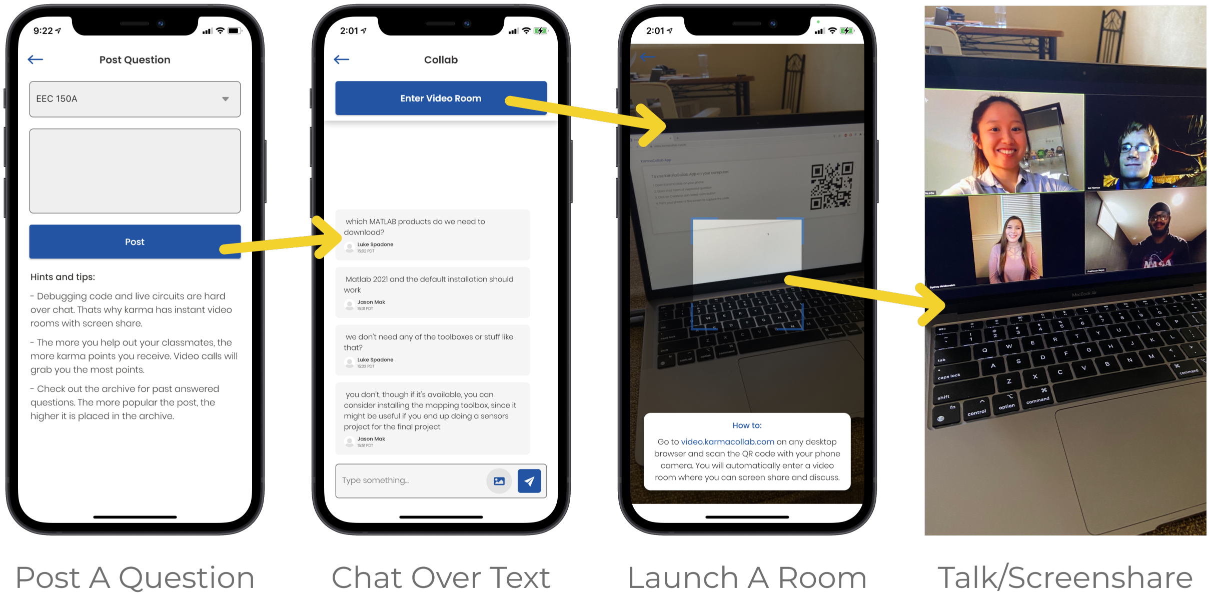

Figure 2: KarmaCollab getting questions answered.

At the top of every post in the active tab of KarmaCollab is a button that will launch a QR code scanner. The video chat automatically launches once the companion web app is scanned from any browser (no login required). KarmaCollab video rooms have no capacity limits and allow for screenshare, which is used extensively in project courses involving simulations and coding.

Self-Managed Archive

KarmaCollab tries a new approach to archiving posts. Other platforms such as Slack, Piazza, and Blackboard allow for an infinitely long archive of all questions posted, sometimes even from past instances of the course. KarmaCollab uses a model more like Twitter, where trending archived topics bubble to the top of the archive, and posts that have lost relevance are expired and deleted. The expectation is that reduced clutter and more intelligent sorting will make the archive more useful to most students. If a question is expired, a student can always ask again as an active question, although it is expected that this will be infrequent.

Leaderboard and Tracking

The app automatically tracks three metrics that are used to determine a students 'karma score' for a class. This karma score places students in a class-wide leaderboard which gives recognition to students who are interacting with their peers. The first metric tracked is passive engagement in the app as a viewer of posts. The second is engagement interacting on different posts through text (over a minimum character length) or uploaded images. Finally, how many live video calls they have participated in with teaching staff or students. Students that are actively helping vs. being helped also get a slight advantage when it comes to karma points in general. The more a student engages with their peers, the more karma points they receive, the higher up they see themselves moving in the leaderboard. A screenshot of the leaderboard is shown in Figure 3.

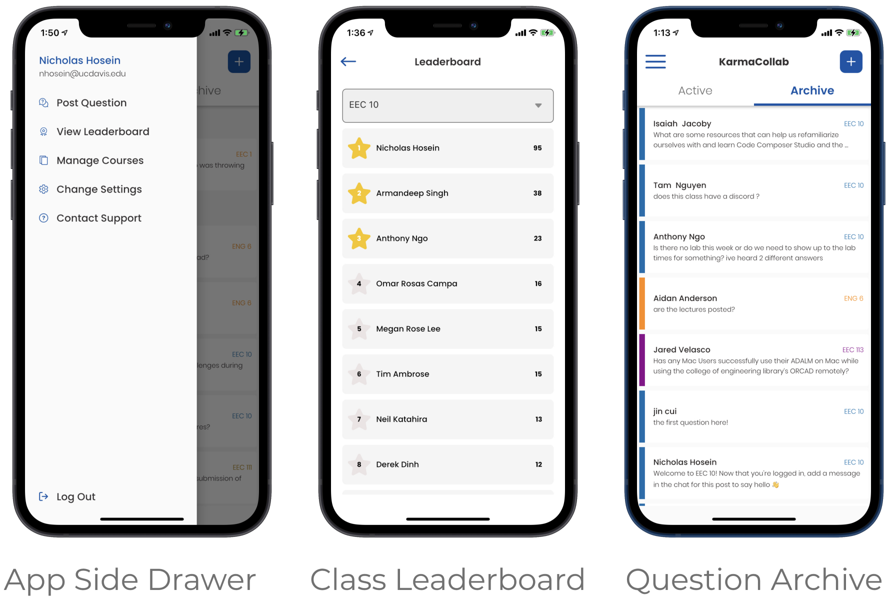

Figure 3: KarmaCollab special features.

Primary Case Study Setup

Practitioners in the STEM field must possess competent problem-solving skills. There may not always be a single step-by-step solution to a problem, thus it is essential to guide learners in STEM to understanding a topic rather than just memorize answers. The path to understanding does not only require analytical skills but social skills. Laboratories, traditionally used in the STEM fields, lean towards in-person, hands-on learning in a lab setting to provide easier collaboration among students. Learning through teaching others, or socialized teaching, sparks deeper learning of a subject as an individual brainstorm's ways of teaching others rather than only focusing on understanding the material. This case study involves comparing KarmaCollab to its baseline. Both accomplish the same fundamental dynamic of social teaching, but KarmaCollab is more automated and technology driven.

EEC 10 - Winter Quarter (Baseline)

EEC 10 Winter Quarter 2021 was a hands-on introductory course to analog and digital circuits where 64 students built a sound following robot using a microcontroller and some basic analog circuits. Students are introduced to the concept of 'boost' which is a reward for proactively participating in the class. In the baseline case study course, students are told that for every 20 boost points earned, they raise their final course grade by one percentage point. If they receive all available boost points available, they get a +10% total grade boost. Course modifications and additions are summarized below.

1. Early Submission Boost - to motivate students to start early, they are offered two boost points per day for up to 5 days to check off labs before the official due date.
2. Student Assistant Boost - if a student gets a lab-verified by teaching staff early, they qualify to be a student assistant at five boost points per 3-hour lab section.
3. Weekend Office Hours - to give more consistent, ongoing help, additional virtual lab hours are held on the weekend.
4. Mentorship Priority - Students that need assistance are divided across virtual rooms, each with a student assistant. Student assistants engage teaching staff directly if they are not able to help a student under their mentorship. This structure provides a benefit to the students getting help and reinforces the concepts learned by the student assistant.

In other regards, traditional course components remain unchanged, including lectures, lab hours, office hours, written midterms, and a final project.

EEC 10 - Spring Quarter (KarmaCollab)

EEC 10 Winter Quarter 2021 was a hands-on introductory course to analog and digital circuits where 70 students built a sound following robot using a microcontroller and some basic analog circuits. Like the baseline course, students are introduced to the boost concept for being proactive. They are given the same +10% final grade shift incentive. The course was run identically to the baseline course other than the exceptions noted below.

1. Student Assistant Boost - At the end of the quarter, the highest-ranking student on the KarmaCollab leaderboard received 25 boost points, the most available. The second highest contributor received 24, so on and so forth.

2. Flexible Lab section - The first 30 minutes of the lab section are held as usual, with the remaining 3 hours 30 minutes continuing on KarmaCollab. TA's perform a checkoff of a lab exercise after the student is done. Checkoffs are scheduled via KarmaCollab, on-demand when students are ready as opposed to during fixed periods like lab time or office hours.

3. On-Demand Office Hours - Two TA's are dedicated to monitoring KarmaCollab outside of lab section times. Students can schedule times to video chat or checkoff via the app.

4. TA Specialization - Instead of each TA performing all tasks (labs, office hours, grading etc.) in Spring, each TA took up a specialty. One TA did all the grading, two took on-demand office hours, one helped run the course, and one created lecture challenges.

5. Group Challenges - Instead of having a lecture during the lecture period, students were randomly broken into groups for challenging group assignments. Lectures are pre-recorded and viewed at home. A challenge could be to create a circuit in a group and show the output or to research an engineering concept and prepare the group to answer questions.

Foundational Theory Overview

The current social and technological landscape is observed, from Facebook, Twitter, Zoom, Piazza, TikTok, etc. The KarmaCollab platform is designed around what currently engages the 18-22 year undergraduate demographic.

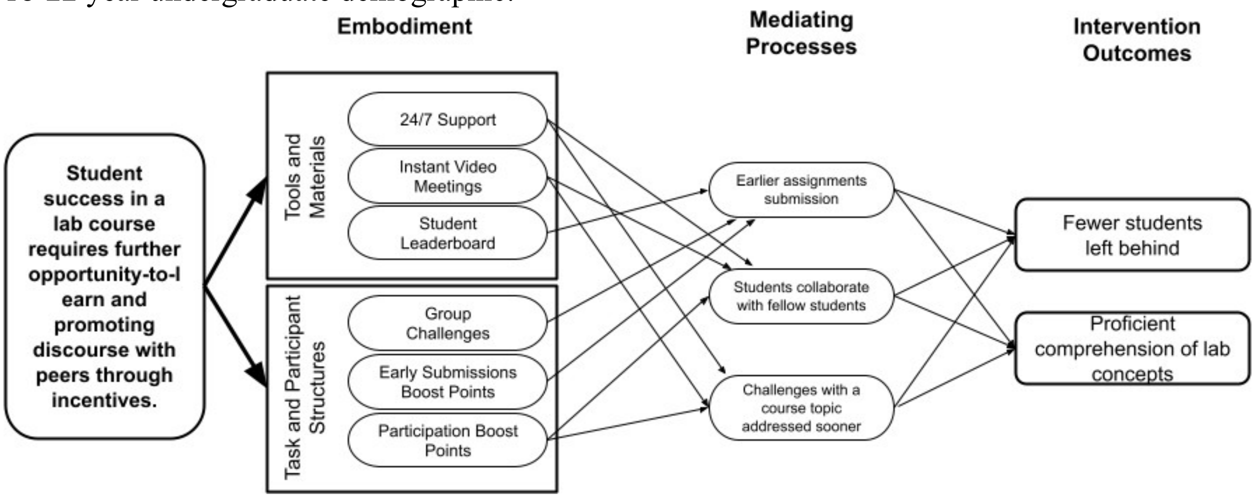

Figure 4: This conjecture map shows from left to right, the assumed theory of aiding learning, the tangible embodiment of how the course was altered in response, the mediating processes expected to result from that embodiment, and finally the measurable outcomes for students.

The preference for using commercial applications as a foundation is due to the lack of custom-developed platforms in academia available to base this work on. In addition, many of the best academic works on the topic are published in the moderate to distant past, making them less relevant when looking at technology-driven by modern day social trends. Instead, academic theory is used to influence how this current day 'engaging' features can be utilized to support education. This research is based on work by del Rosario et al[6] and the underlying principle that when communication bottlenecks exist it stifles peer-to-peer based learning. The solution is to increase communication concurrency by eliminating teaching staff as the intermediary, increasing asynchrony of communication by allowing discussion outside of official class hours, and using teaching staff as moderators and less as all-knowing oracles.

These principles drive the KarmaCollab app experiment. The EEC 10 Winter 2021 class (referred to as the baseline) used the suggested curriculum format proposed by del Rosario et al[6]. This current work extends these practices through the KarmaCollab app platform during the subsequent run of EEC 10 course in the Spring of 2021.

Study Conjecture Map

To formalize the design of the learning environment, a conjecture map is used as developed by

Sandoval et al [7]. The conjecture map visualized in Figure 4 is broken into four elements. The high-level conjuncture describes how to support the kind of learning we are interested in supporting in the specific context. That conjecture is then realized through the embodiment of the specific design. The embodiment is assumed to create mediating processes which in turn result in our desired measurable outcomes. As will be discussed further in the following sections, fewer students were left behind with 7.8% in the baseline and 4.3% in the KarmaCollab based course, which supports the first of our desired outcomes. Here, "left behind" is defined as receiving below a 50% average grade on their lab assignments. Secondly, we consider that in both the baseline and KarmaCollab course, the average lab scores were both 87%, implying that students in each cohort learned equally as well. This consistency supports our second outcome.

In the following data analysis sections, the grade information between EEC 10 Winter 2021 (baseline) and EEC 10 Spring 2021 (KarmaCollab) are compared with app engagement data considered alongside. Student administered surveys are then presented with insights into student sentiment about the course changes. Teaching assistant interviews then give a perspective of how the teaching staff viewed the use of KarmaCollab in the classroom.

Analysis of Application Data

The application is built and maintained using Google Firebase, which provides a reliable and scalable backend infrastructure for web and mobile applications. The Firebase database is used to store all user data and interactions within the platform.

To analyze the data, various tools such as Tableau, Excel, and R Studio are used to query and extract relevant information from the Firebase database. These tools enable the KarmaCollab team to gain insights into the user behavior and improve the platform's features and functionality.

A key metric that the KarmaCollab team tracks is the response time of TAs and students to posted questions. On average, it takes approximately 4 hours for a TA or student to respond to a question. This metric could be used in future iterations to ensure that students receive timely support and assistance when needed. Metrics provides us with information used to further streamline the communication process with the app and implementing new features that make it easier for TAs and students to collaborate effectively.

Analysis of Grade Data

Course grade data for Winter 2021 (baseline) and Spring 2021 (KarmaCollab) were anonymized and studied. Only lab scores are evaluated as an indicator of comprehension as other aspects of the course, such as quizzes, were not parallel comparisons. Any student who scored 0 on all assignments during the entire quarter course was assumed to not be an active participant in the class and, hence, removed from the evaluation. Spring 2021 boost points were out of 100 total, with Winter 2021 out of 150. Winter 2021 boost points are adjusted to a scale 0 to 100 using the following min-max with

$$z_i = \frac{x_i - \min(x)}{\max(x) - \min(x)} * 100$$

Where z_i is the i_{th} normalized value in the Winter quarter boost point dataset, x_i is the i_{th} value in the Winter quarter dataset, min(x) is the minimum value in the Winter quarter boost point dataset, and max(x) is the maximum value in the Winter quarter boost point dataset.

Both courses had the same 10% incentive for getting boost points. Average lab grades are evaluated against boost points to determine the bivariate correlation using Pearson coefficients. The results can be seen in table 1 with a plot of average lab scores vs boost points shown in Figure 5. The correlation between boost points and lab score is 0.319 for Winter and 0.448 for Spring. Thus, correlation is significant at the 0.05 level for Winter and 0.01 for Spring with a sample size of 64 and 70, respectively. The positive correlation in both the Winter (baseline) and Spring (KarmaCollab) courses demonstrate that students with higher total boost points had a better comprehension of the material. The scatter plot shows the baseline course had more students struggling, with 7.8% under the 50% lab score mark. In the KarmaCollab version only 4.3% of students were under the 50% mark. We expect this could be due to the ease of getting help with the app. The average lab score in both courses were 87% indicating that comprehension was equal across both courses.

	EEC 10 Winter	EEC 10 Spring
Pearson Correlation	0.319*	0.448*
Sig (2-tailed)	0.01	0
Students in study	64	70

Table 1: Bivariate correlation between lab scores and boost points for Winter and Spring Quarter. *Correlation is significant at the 0.05 level (2-tailed). *Correlation is significant at the 0.01 level (2-tailed)

Analysis of App Data

Data is extracted from the KarmaCollab database and analyzed to gain insights from student chat, video, and question post engagement. Only aggregate lab scores and boost points are considered for the rest of this analysis. The lab grade data is cross-referenced with app data to add additional dimension to the analysis.

Chat, Video, Question Engagement

In Figure 6, chat, video, and question post engagement are shown with respect to the average lab score in just the first two weeks of the course. Figure 7 shows the same data but aggregated over the entire quarter, not just the beginning. Chat engagement consists of how many times a student posts a message (over a specific minimum character limit) or an image in one of the discussion rooms. Video engagement involves participating in a video call with at least one other student or teaching assistant present. Question engagement consists of any question posted by the student asking for help or requesting a check-off on a lab. In the first two weeks of the course, there seems to be a disproportionate number of questions being asked relative to actual communication via chat or video on the lowest end of the grade spectrum (30-39% grade level). The students on the highest end of the spectrum (100+ % grade level) were asking many questions but also engaging on chat and video during those first two weeks. As the quarter progressed, the mid-range achievers (60-89% grade level) caught up in engagement compared to the first two weeks. In general, the ratio of chat, video, and posts seem to be about equal across grade ranges except at the very lowest end. This range is somewhat unexpected as one would think that the high performers would consist of the naturally talented students who would ask very few questions and primarily help others. With high performers, they not only chat more than most of the other groups, but they also asked the most questions throughout the class.

Analysis of Survey Responses

In addition to our primary case study course, EEC 10, surveys were administered to three additional courses using the surveying platform Qualtrics. The four courses during the Spring 2021 quarter that were surveyed were EEC 10 (70 enrolled), EEC 150A (35 enrolled), ENG 6 (204 enrolled), and ENG 100 (74 enrolled). Each course utilized KarmaCollab differently based on the instructor's preferences. Incentives and utilization for courses are summarized here.

- EEC 10 (Intro to Digital and Analog Systems) Incentives offered, and participation required.
- EEC 150A (Signals and Systems) Incentives offered but participation optional.
- ENG 6 (Engineering Problem Solving) Incentives not offered and participation optional.
- ENG 100 (Electronic Circuits Systems) Incentives not offered and participation optional.

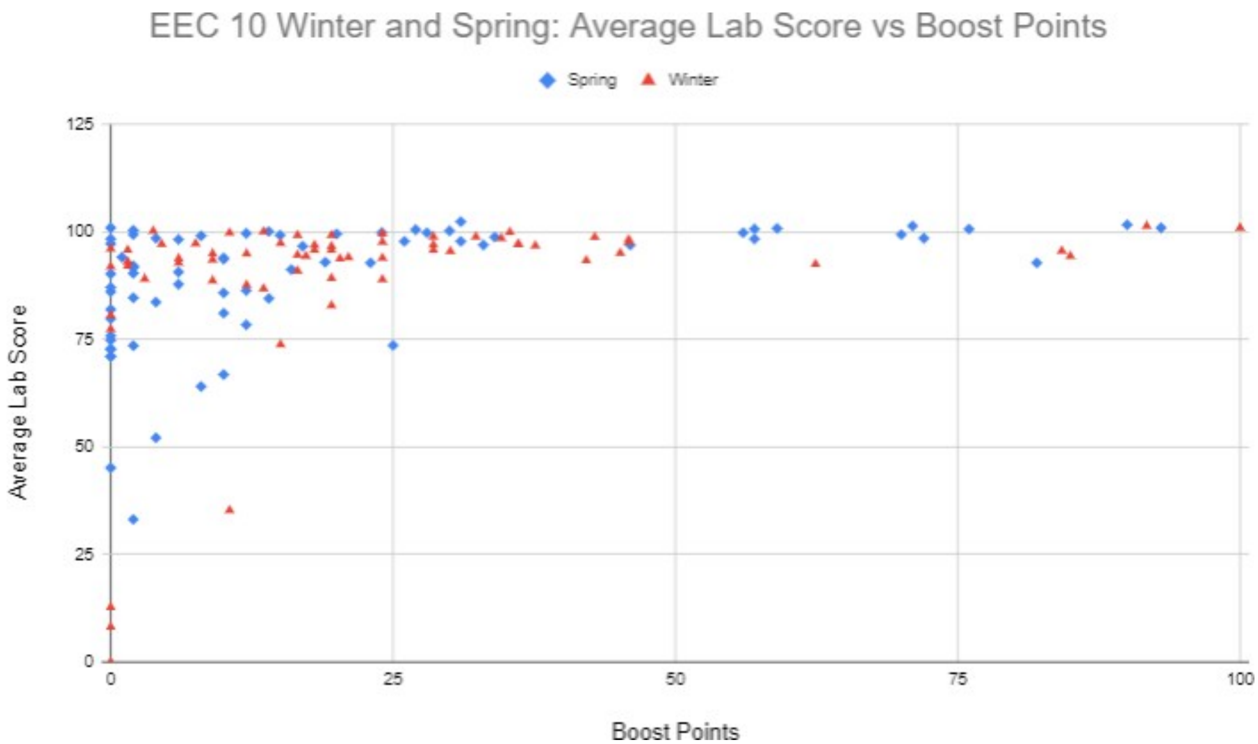

Figure 5: Scatterplot of average lab scores vs boost points for Winter and Spring Quarter.

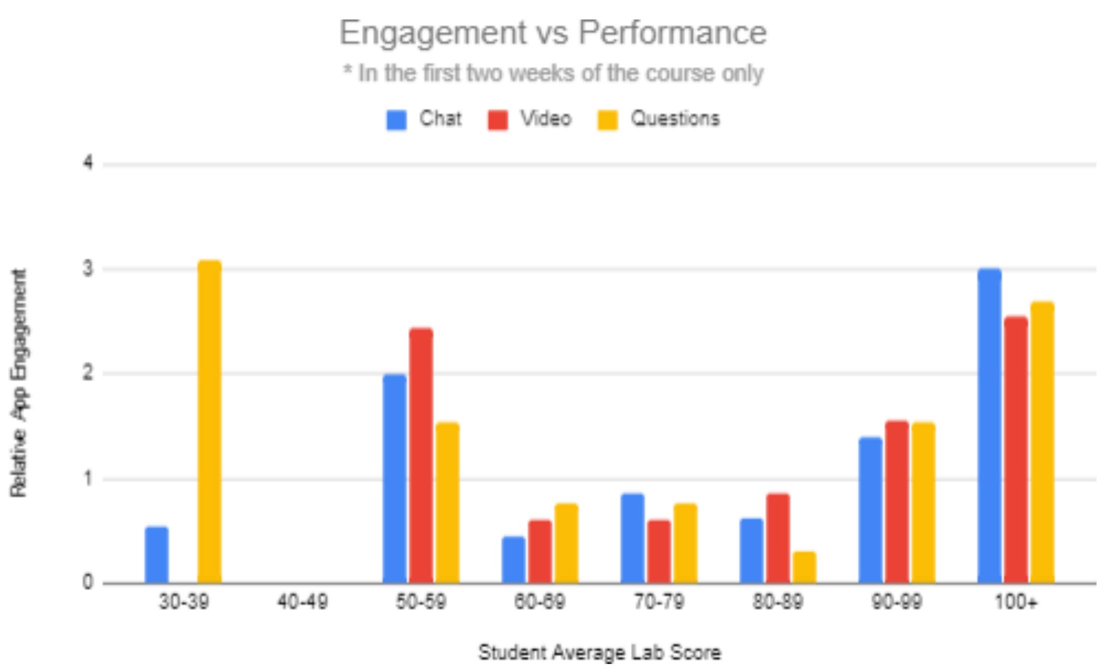

Figure 6: Chat, video, and question engagement for the first two weeks of the course evaluated by average lab score. The 100+ category is due bonus questions on labs that push lab grades over 100%.

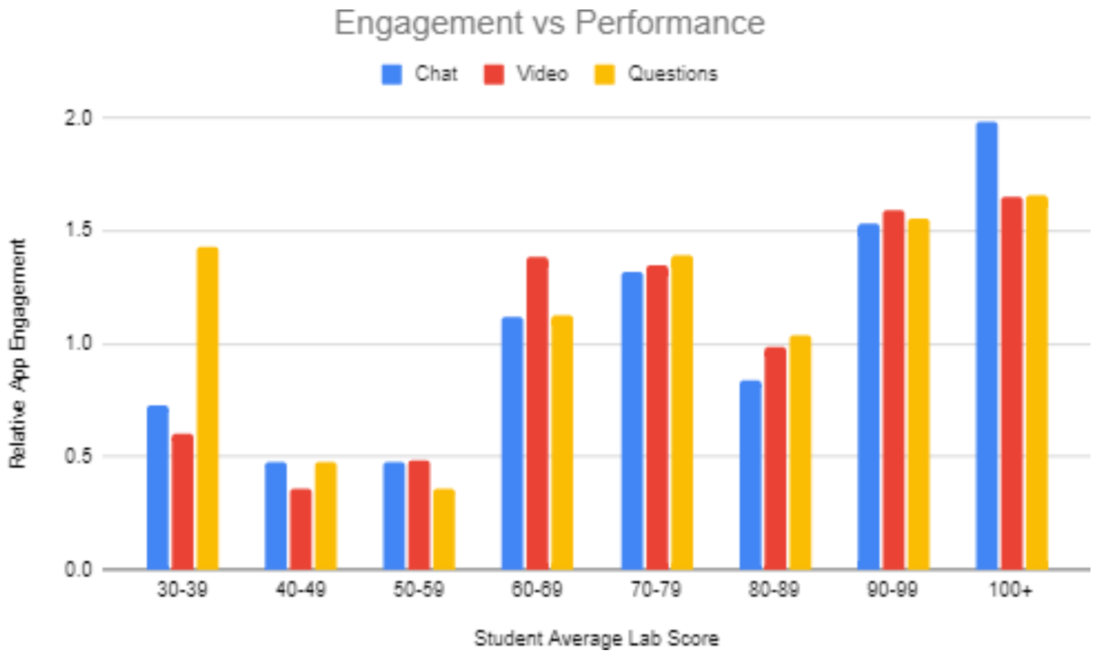

Figure 7: Chat, video, and question engagement for the entire quarter evaluated by average lab score.

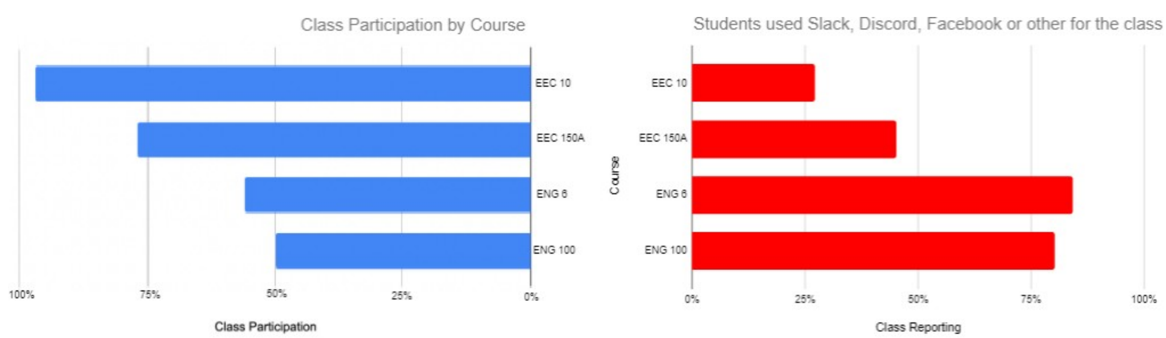

Figure 8: Student participation on KarmaCollab across courses.

Due to the differences in implementation, a full set of survey questions were sent to EEC 10 with only relevant questions were sent to the other three courses. For this paper, EEC 10 is considered the primary subject of the case study, given it was the only class that used KarmaCollab at its full capacity. The other classes are used as a value-added for comparison to EEC 10.

Figure 8 shows us that EEC 10 and EEC 150A had the most participation on KarmaCollab, probably due to the fact there were incentives to use the app. ENG 6 and ENG 100 show less participation in KarmaCollab and more participation in other platforms (i.e. Slack, Discord, Facebook). There is an inherent deterrent for students to use official platforms as they know teaching staff will be viewing what is posted. Backchannels such as a private group chats allow students to trade answers and cheat on assignments without repercussions. Students overwhelmingly liked the idea of getting boost points as a reward for not procrastinating on lab assignments, as is shown in Figure 9, however, there seems to be no consensus if having a boost point linked leaderboard on the app motivated students to engage with their classmates.

Teaching Staff Interviews

An interview was conducted with the 6 EEC 10 Spring 2021 teaching assistants (TAs). Overall, TAs agreed that KarmaCollab provided more flexibility for students and themselves. Students were able to turn in their assignments and checkoff their lab with a TA at any time over video chat. The TAs observed that students had an initial shock to the new class format but adjusted quickly. When students experienced glitches in the app it caused them to question the technology. There were expectations students had from using more established platforms like Slack and Piazza which were not met by KarmaCollab at the time of running the test. TAs received student feedback that, although they would like to assist others on the app, their life outside of class was too busy. Many students wanted to schedule KarmaCollab time instead of jumping on in the moment, showing that for some, more structure is preferred. TAs preferred the "specialized" format in which they were able to focus on one aspect of the course (i.e., grading lab assignments, monitoring KarmaCollab, course logistics, etc.) as opposed to dividing their time on many different tasks. Having students answering most of the questions on the platform before they even got there was a big help in reducing TA workload.

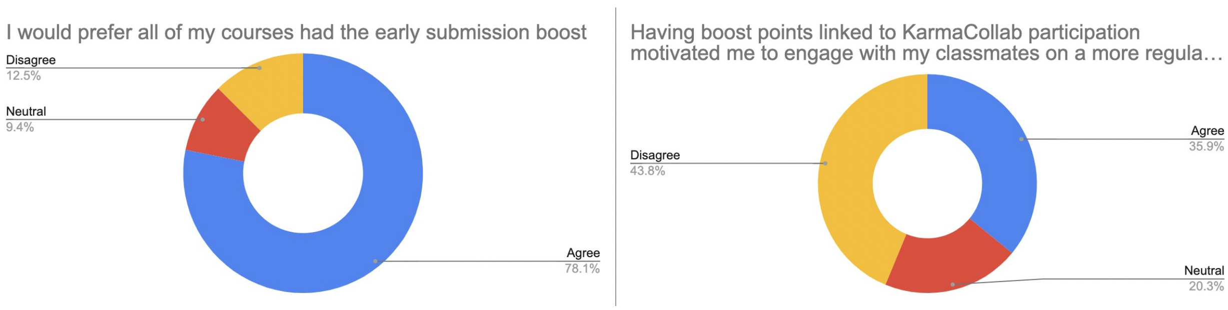

Figure 9: As reported for the primary case study course EEC 10 Spring 2021. [Left] Response to question, "I would prefer all of my courses had the early submission boost". [Right] Response to question, "Having boost points linked to KarmaCollab participation motivated me to engage with my classmates on a more regular basis."

Conclusion

At the beginning of the COVID-19 shelter in place order, many universities frantically transitioned to an online format from their traditional in-person format. The focus was originally on making resources and course material available online followed by exploring and testing different technologies to streamline remote learning. KarmaCollab was an experimental platform, run from any smartphone, that allowed students and teachers to recreating some of the sparks of in-person learning while operating remotely. KarmaCollab utilizes concepts such as gamification via the leaderboard, students teaching students, and quick lab support through instant video chat all done in a seamless and automated way. Although KarmaCollab is not favored (and was not intended) to replace the traditional in-person lab course, it does have the potential for enhancing the in-person or fully remote classroom experience.

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