Lessons Learned Using Slack in Engineering Education: An Innovation-Based Learning Approach

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Abstract

In Fall 2019, we taught a Cardiovascular Engineering course using a blended approach: a mix between online instruction and face-to-face environment. This course is an interdisciplinary Innovation Based Learning (IBL) class that combines both undergraduate, graduate students, face-to-face and distance education students from different institutions. To foster student collaboration, we decided to use Slack for both instructor-to-student and student-to-student communication. This paper explores the impact of Slack on the course.

First, we compiled Slack analytics over the semester, such as the number of messages sent, channel activity, and student engagement. Second, we shared a comprehensive survey about Slack at the end of the course. Finally, we interpreted the latter in light of the former to draw our conclusions and formulate a number of recommendations regarding the use of Slack. Our analytics showed students engaging on Slack throughout the semester, with activity intensifying as course deadlines approached. Other findings indicated students favored direct messages over public ones and a custom engagement metric highlighted the importance of informal Slack channels.

Our survey showed that students found Slack had a positive impact on the course. Students appreciated Slack being an all-in-one communication tool, they liked some of its features, and they thought that it struck a good balance between formality and informality.

However, students disliked certain aspects of Slack channels, reporting they had trouble finding older messages, and faced various technical issues. Most notably, students reported preferring email over Slack when it came to course announcements.

In light of our findings, we formulated a number of recommendations regarding the use of Slack in an educational setting. These include teaching students how to use Slack early on in the semester, having a predefined student-focused channel structure, and practicing "tough love" — that is, deliberately delaying feedback to encourage students to collaborate on solving problems.

Introduction

In Fall 2019, we taught a class called Cardiovascular Engineering under the Electrical and Computer Engineering Department of North Dakota State University. The class leverages Innovation Based Learning (IBL) [1], a pedagogy similar to Project Based Learning [2] but emphasizing the creation of novel ideas and the development of projects with social impact. Besides having to meet IBL's requirements, we faced a challenge: our 36 students were based in different locations. Most were spread across two different campuses. Some were taking the course online from various locations across the country. Good communication, inside and outside the class, had to be achieved under these constraints since good communication tools in education are a major requirement to create learning environments that allow students to express creativity inside and outside the class [3].

With that goal in mind, we chose to use Slack (the free version) for class communication, including instructor-to-student and student-to-student communication. In addition, we used a combination of technologies allowing students to explore and embrace various tools used in industry — giving them an edge during recruiting.

The technologies ecosystem was hosted on a custom PHP-based web tool called MOOCIBL [4]. It was guided using FOAs geared toward improving student engagement [5]. MOOCIBL and FOAs provided a dynamic environment that enabled the use of IBL tools such as Slack, Prezi, Mentimeter, Tinkercad, or draw.io. Students were monitored on MOOCIBL with a view to the future development of machine learning algorithms supporting IBL [6]. Students engaged in active learning both in and outside class via Massive Open Online Courses (MOOCs) and our Small Private Online Course (SPOC), resulting in a blended approach [7].

We chose to use Slack for all class communication because it has shown some success in engineering education in the recent past [8], [9], and because of its popularity in industry [10] and in some educational institutions [11].

Slack Channel Structure

Students were told that Slack would be the class' primary communication tool. A dedicated Slack workspace was created for the semester. Students were allowed to join in the first week of class. The workspace channel structure looked as follows:

- **#general**: This channel was used for class announcements, so most messages were from instructors. It was starred so that it would appear at the top of the channel list.

- **#news_opportunities**: This channel was used for sharing news and opportunities such as contests, grants, and conferences. It was also starred.

- **#calendar**: This channel was connected to Google Calendar to show the course schedule — most notably, deadlines.

- **#chapter_questions**: There were several of these channels, each tied to a chapter of an online class students had to take on MOOCIBL. Students had to post questions about each chapter and collaborate to answer other students' questions.

- **#presentations**: This channel was used to share presentation files with classmates and instructors. It was a repository of all the presentations given by students throughout the semester (about five per group).

- **#instructors_only**: This channel was used by the teaching staff (six people) for communication, collaboration, and coordination.

- **#random**: This channel was used for any communication that didn't fit in the other channels. Messages could be informal but should be relevant to the class.

Methods

At the end of the term, we shared a comprehensive survey with students. Ten questions were about Slack (in Appendix). This study focuses on those. Participation was voluntary: 24 out of 36 students (66.7%) took the survey. Note that not all students answered all questions. In addition, we extracted general analytics from Slack. The data are non-identifying. We analyzed the survey answers and analytics data and interpreted the former in light of the latter to draw our conclusions.

Results

Slack Analytics

The data consist of:
- 5742 messages (the free version of Slack allows up to 10,000).
- 17 public channels.
- 46 total members.
- 6 integrated apps.
- 6 GB of storage used.

Workspace activity was tracked from late August to late December 2019. Note in Figure 1 the steady decline of the usage of Slack over the semester. This was expected as some students may disengage or become busy with other classes as deadlines approach.
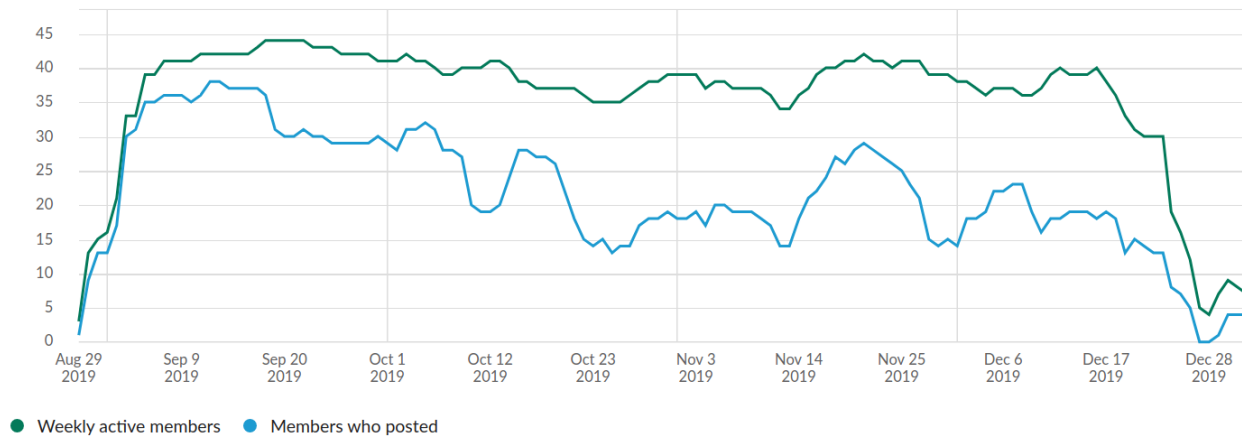

Figure 1. Weekly active members and members who posted on Slack during the semester.

Beyond facilitating communication, the goal of Slack was to foster collaboration between peers. Table 1 shows the number of messages sent on Slack over the semester.

	Messages Sent	Percentage
Public Channels	574	10%
Private Channels	517	9%
Direct Messages	4651	81%

Table 1. Messages sent over the semester: public vs. private vs. direct messages.

There were eight times as many direct messages as public messages. This finding surprised teaching staff since students had been encouraged to collaborate openly, and tools had even been shared to support open exchange. The stark contrast between the figures suggests that while students want to communicate, they are less inclined to do so in public.
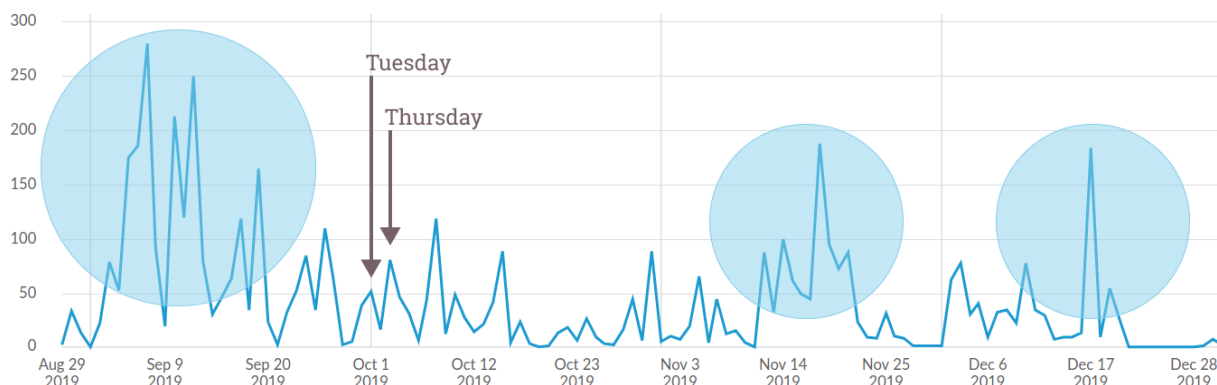

Figure 2. Messages sent over the semester, with three peaks of activity.

When looking at the number of messages sent over the semester, we noticed three peaks of activity. These roughly correspond to the start of the course, the first global evaluation, and the end-of-course submission deadline. Figure 2 suggests a correlation between evaluation periods and outstanding Slack activity. Furthermore, we can see local peaks that lined up with the meeting days (Tuesday and Thursday) of the face-to-face component of the blended class.
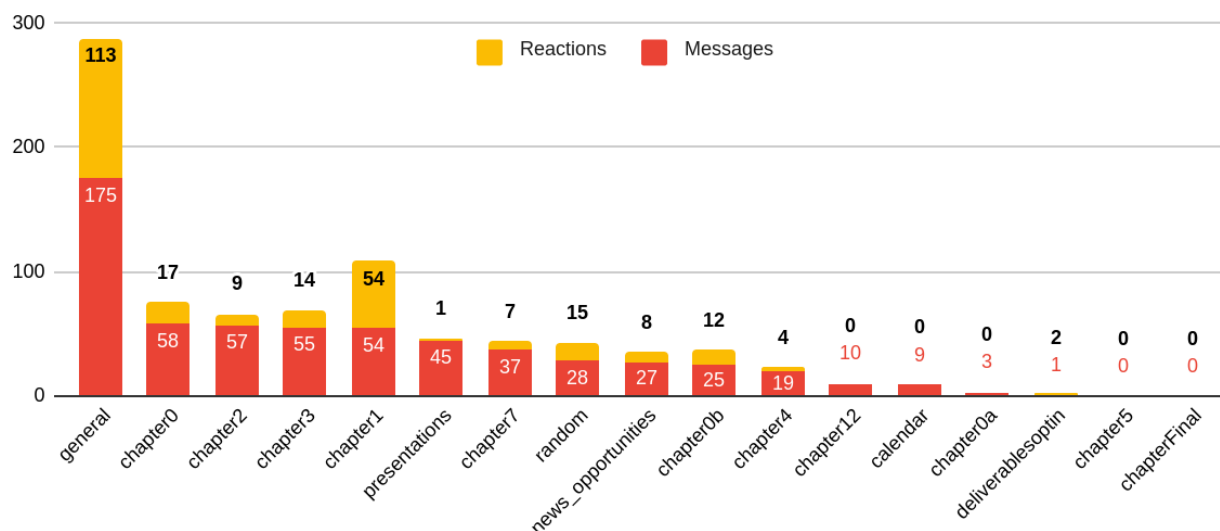

Figure 3. Messages and reactions per channel.

Next, we sorted the channels according to the number of messages posted in each. Figure 3 shows high activity in the #general, #chapter, and #presentations channels.

We see that the #deliverables channel barely saw any activity. This channel was supposed to serve as a safe space for students to showcase their work — for instance, key findings — and was thought as an instrument to bolster motivation and encourage feedback.

The #deliverables channel may have been misunderstood by students. Or perhaps they simply preferred sharing their progress and feedback through other avenues, such as direct messages, as suggested by Table 1. Slack can provide great insights into how the class is progressing and help determine the level of student engagement on a per chapter or per topic basis. As seen in Figure 3, in addition to messages, Slack logged the number of reactions across channels. On Slack, users may attach emojis to messages: these are called "reactions". For instance, we can see that the #presentations channel only had one reaction; this is unsurprising considering that the channel is simply a repository for presentations.

The #general channel gathered the most reactions, followed by the #chapter channels. But we sought to measure channel engagement via a combination of the number of posts and reactions. Let's calculate channel engagement as follows:

$$engagement = \frac{2 * reactions}{reactions + messages}$$

Equation 1. Custom engagement metric.

This formula takes into account both messages and reactions, emphasizing the latter: given a number of messages in a channel, the more reactions they prompt, the higher the channel's engagement level. Based on Equation 1, we can sort channels as shown in Figure 4.
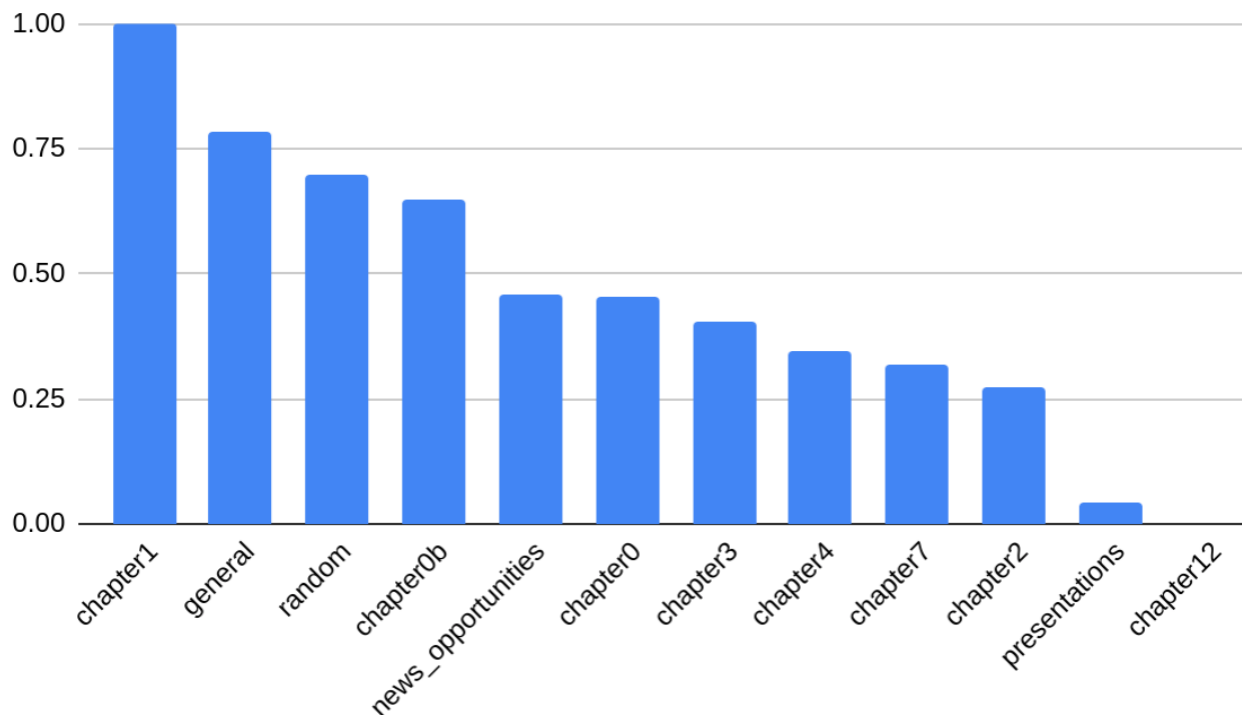
Figure 4. Slack channels (with 10+ messages) ordered by custom engagement metric.

Besides reinforcing previous observations — that the #general and #chapter channels see significant engagement — our new metric denotes the importance of informal channels, such as the #random channel and, to a lesser extent, the #news_opportunities channel. This isn't a

surprise: informal conversation is a natural part of the social aspects of learning. And this remains true even when a course is taught online. When face-to-face exchange is not an option, students gravitate toward alternatives, such as informal channels on Slack.

One may argue that messages matter more than reactions. But since our goal is to foster collaboration, we are more interested in students responding to others than in messages that only exist in a vacuum. Reactions being the purest form of response available on Slack, we think they can be a good indicator of engagement. Future research should include distinguishing between students and teaching staff messages. At the moment, we are constrained by the capabilities of Slack's free analytics.

4.2. Survey: Quantitative Questions

Students were asked 7 quantitative questions (Q1 to Q4 and Q8 to Q10 in Appendix).
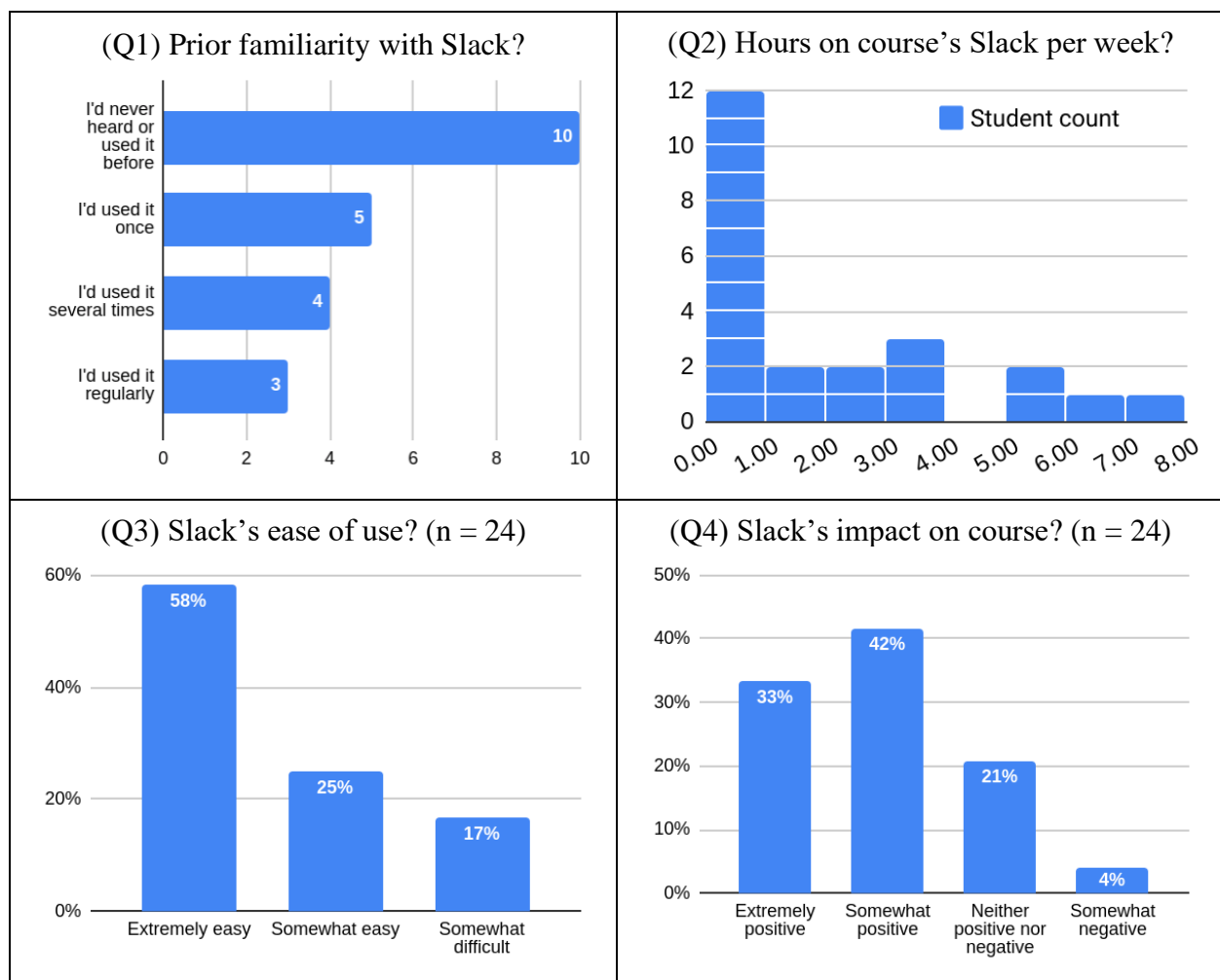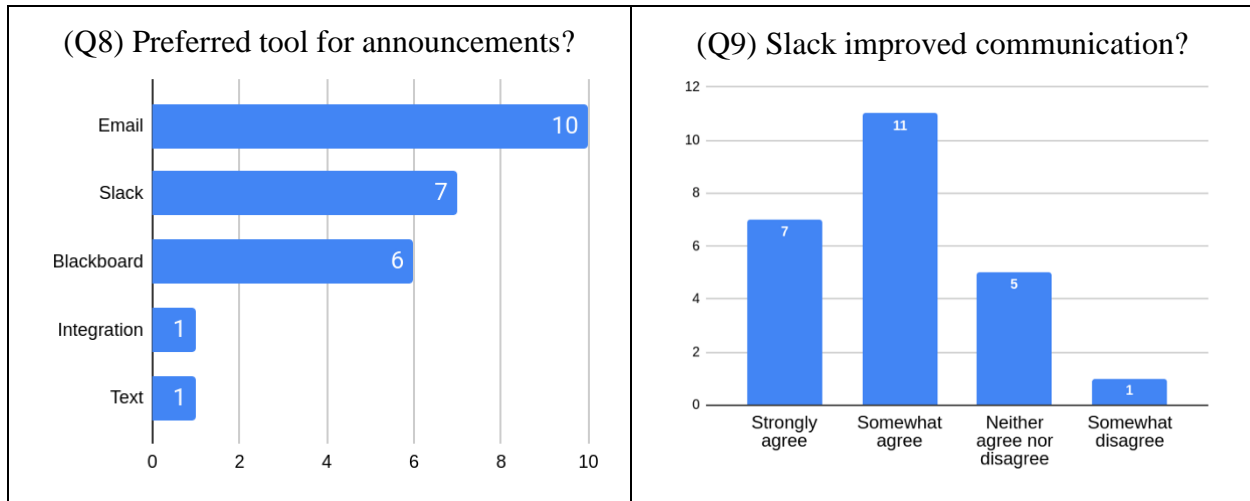
Figure 5. Slack survey: answers to the quantitative questions.

The overall opinion, as shown in Figure 5, was that Slack is easy to use, that it positively impacted the course, and that it improved communication and collaboration. These findings are all the more positive considering that almost half the students had never used Slack before.

Many students dedicated less than an hour to Slack each week. Even though we are dealing with engineering students, we noted some resistance to change. For instance, most students preferred email over Slack for course announcements. Although using Slack was repeatedly encouraged, many students continued to reach out to instructors via email.
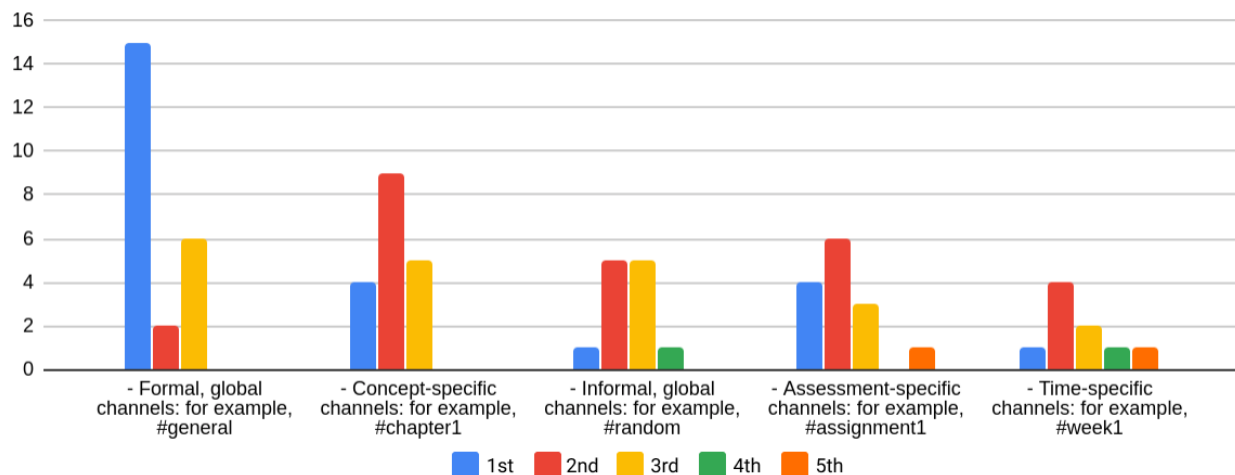

Figure 6. Relative importance of different channel types.

Students were asked to rank different types of Slack channels (Q10 in Appendix), such as general-purpose channels or time-specific channels, according to their importance. We observe in Figure 6 a strong preference for general-purpose channels, followed by concept-specific channels, such as #chapter. The predilection for general channels may partly be explained by course announcements being shared on #general.

The rest of the data suggest assessment-specific channels to be the next priority and favored over time-specific channels. This may be due to different students progressing through the course at different speeds: concept-specific channels aren't tied to a particular timeframe and are therefore more flexible than time-specific channels. Other classes that use Slack may have assessment-specific or concept-specific channels. In this class, we only had chapter-specific channels, which may have biased the students' perceptions. Further investigation on how to optimize channels structure is required.

Note that some students ranked their top-five options, while we only asked them to rank three. In addition, three students chose a custom option, such as "presentations."

4.3. Survey: Open-Ended Questions

The survey included three open-ended questions (Q5, Q6, and Q7 in Appendix). Their goal was to capture a nuanced, qualitative perspective regarding Slack's impact on the course.

Students found numerous benefits to Slack — most notably:

- **All-in-one communication**: Students enjoyed the fact that Slack centralized all conversations in one place, be it with other students or instructors.

- **Features**: Students liked being able to upload and share files on Slack, being able to search messages, and being notified when announcements were posted.

- **Engagement**: Students appreciated Slack being a happy medium in terms of formality between text messages (informal) and email (formal).

Other benefits mentioned include: Slack's ease of use, the ability to create groups seamlessly, and the speed at which students could post questions and get answers.

Students also found some negatives to Slack — most notably:

- **Joining channels**: Students complained about channels' lack of visibility: there were no notifications when channels were created, and students had to join each manually.

- **Too few or too many notifications**: Some students reported not always receiving notifications, and some reported receiving too many.

- **Messages getting buried**: Some students found it hard to find some of the older content posted on Slack.

Other negatives mentioned include there being too many channels, and Slack's free plan 10,000 messages limit — although we didn't reach said limit, a student mentioned that just knowing that their older message might be deleted discouraged them from engaging fully.

We note that one fourth of the responders didn't list any negative aspect of Slack. By contrast, almost all responders listed at least one benefit. This further gives weight to the idea that, overall, Slack had a positive impact on the course.

Finally, we asked students how the use of Slack could be improved. Several suggestions were about channels:

- **Channel overview**: Some students found the channel structure confusing and suggested providing explanations on the purpose of each channel.

- **Have all channels at the start**: This semester, channels were added as the course progressed. Some students would prefer them being available all along.

- **Adding students to channels automatically**: Students disliked having to join channels one by one as they were created.

Some students requested general explanations about Slack. Although most found Slack easy to use, we suspect that some common complaints (such as missing notifications) were due to incorrect app settings. Explaining Slack's basic settings to students at the start of the class could help preempt some of those complaints.

Conclusions

Lessons Learned and Recommendations

Based on our experience using Slack in this blended approach to engineering education, we recommend the following:

- **Start the course with an introduction to Slack**: Even though students find Slack easy to use, they may not be aware of some of the tool's important features. One should also cover the practical benefits of Slack, such as its popularity in industry. This would ensure that students understand both how to use Slack and why to use it.

- **Create all channels in advance**: Make sure students know how to find and join channels. Alternatively, instructors themselves can add students to channels. But don't overdo it. Otherwise, you could substitute one problem for another: all channels may not be relevant to all students.

- **Warn students about potential bugs**: For instance, let them know about the missing-notifications bug Slack seems to have on certain platforms. More generally, teach them how to use Slack's help center [12] so they can be self-sufficient.

- **Instruct students on how to search through Slack**: As messages pile up, content gets buried. To find it, a convenient way is to use Slack's search feature. However, it isn't always intuitive. Some early guidance is advisable.

- **Introduce the idea of "tough love"**: Tough love involves deliberately waiting some time before answering student questions to foster collaboration and camaraderie [13]. Find a balance between immediate feedback [14] and overly delayed feedback.

Competition

Slack is not the only tool available for online communication and collaboration. Their main competitor, Microsoft Teams, offers similar functionality and has been gaining momentum in terms of industry adoption.

Some students dislike switching between communication tool and learning platform. Instead, they would prefer communications to be integrated into the LMS. This may have benefits. But it may also be a disservice to students, robbing them of the opportunity to learn a new tool.

It would be interesting to further research how Slack stacks again alternative software solutions when it comes to communicating in an educational context.

Innovation

Our blended IBL approach to education requires little oversight in order to spur creativity and innovation. If students are provided with the appropriate communication tools, collaboration naturally follows. Slack allowed this by serving as an all-in-one platform for students and instructors to communicate, and as an archive of past exchanges.

Engagement metrics underpinned by two-way communication can provide valuable insights on how to manage a class. Slack analytics can help quantify the levels of discussion and collaboration. By observing how activity peaks and drops correlate with particular activities, we may deduce which course aspects bolster discussion, and which stifle it.

In the near future, we could imagine automated tools able to evaluate the quality of student interactions across different platforms, although how much can be inferred from logged communications data raises questions that go beyond technology.

In conclusion, Slack proved to be a useful tool in our engineering course. Students found it easy to use and reported that it facilitated collaboration and innovation. The perspectives shared by students show that innovation is a very hard thing to teach; it requires laying a solid foundation, supporting engagement, and fostering intrinsic motivation.

This model may not work with all students. But with some, it works very well. For those students, the freedom afforded by collaborating with peers and producing high-impact academic deliverables is a way to feed the fire of their own creativity.

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Appendix

Student Survey Questions

Q1) How familiar were you with Slack prior to the course?
Pick one: I'd never heard of it nor used it; I'd heard of it but never used it; I'd used it once; I'd used it several times; I'd used it many times.

Q2) On average, how many hours per week did you spend on the course Slack?

Q3) How easy or difficult did you find using Slack in the course?
Pick one: Very difficult; Difficult; Neutral; Easy; Very easy.

Q4) How positive or negative was the impact of using Slack in the course?
Pick one: Very negative; Negative; Neutral; Positive; Very positive.

Q5) Which aspects of using Slack in the course, if any, did you find most beneficial?

Q6) Which aspects of using Slack in the course, if any, did you find most detrimental?

Q7) How could the use of Slack in the course be improved?

Q8) Through which communication tool do you prefer receiving course announcements?
Pick one: Email; Blackboard; Slack; Other; No preference.

Q9) Would you say Slack improved communication in the class?
Pick one: Strongly disagree; Disagree; Neutral; Agree; Strongly agree.

Q10) Which type of Slack channel do you think is the most important in a course?
Pick as many as you want, sorted by order of importance — write "1" next to the most important, "2" next to the second most important, etc.:

- Formal, global channels — for example, #general
- Informal, global channels — for example, #random
- Time-specific channels — for example, #week1
- Concept-specific channels — for example, #chapter1
- Assessment-specific channels — for example, #assignment1
- Other
- No preference