Supplemental Materials

"Classroom" Set-up

*Discord* is provided as a free service, and users, aged 13+, create an account with an email address. The platform can then be accessed through a Web browser or a stand-alone app available on computer or personal device. For a monthly fee, *Discord* provides higher resolution video and screen sharing, amongst other benefits, in their Nitro package. Nitro was not used with these implementations.

Channels were created and organized into categories as described in Table S1 (Appendix 2). While a standard build was utilized, servers were tailored to specific classes. After building the server, the professor sent students invitations to join it via their campus email addresses. Roles were assigned and color-coded to help members with identification—“prof” and “TA” were separate roles but effectively had the same permissions. Each lab section had its own role and color so that it was easy to identify which student was in which section. In addition, students only had access to the channels in their own lab section, reducing the clutter they saw on the server. Creating a server and setting up channels were concise processes that took the authors no longer than 30 minutes. The authors started with the following guide: [https://www.howtogeek.com/364075/how-to-create-set-up-and-manage-your-discord-server/](https://www.howtogeek.com/364075/how-to-create-set-up-and-manage-your-discord-server/)

While anything posted in a non-private channel is viewable by all on the server, mentioning roles or individuals with @ alerts them directly, calling attention to a particular person or group of people. Mentioning @Mon, for example, was used to send reminders directly to the Monday section. Groups for labs, peer-review of lab group writing, and lecture discussion were created and assigned by @ing students in the appropriate text channel. Whilst working in lab groups in voice channels, students frequently called an instructor to their channel by using @prof or @TA to ask for help. When students were in breakout groups, instructors could call them back by using the tag @everyone to alert them to rejoin the general voice channel. Instructors could also drag students back individually.

TAs, regardless of section, could access all channels, but each student had permissions to see only the channels in their section in order that clutter and notifications were reduced for them. Even so, a few students felt overwhelmed with notifications. The default setting for *Discord* is to send notifications to users whenever a message is posted in any text channel on the server they have joined. Each individual channel, however, has settings changeable by the user, such as the ability to mute it. This will turn off notifications for two to eight hours, the next day, or until the user unmutes it. Muting a channel does not change permissions to view that channel. By utilizing this function to eliminate notifications of activity in other lab groups, students and instructors were able to streamline their experience on *Discord*, limiting the feeling of being overwhelmed and allowing them to focus their attention. The rare student raised concerns about *Discord* making it difficult to get away from class, but most students found muting channels in which they were not involved sufficient for their needs. For those students who find the tool intrusive to other aspects of their life or find it difficult to disengage from the classroom outside of school hours, it might be useful for them to mute the *Discord* app during off hours.

In order to introduce students to *Discord* and to keep a record of to whom each account belonged, each student was required to DM their names, student IDs, and section information to the professor and their TA. Once a student was checked off of the roll, they were asked to change their nicknames to their preferred name paired with their last name. Nicknames are screen names in *Discord* and
can be different for each server for which a user is a member; they are independent from usernames.

Discord allows developers to create “bots” that server owners can add to assist the running of the server. Here, Simple Poll (discords.com/bots/bot/324631108731928587) was employed to easily create polls for students. Students responded with emojis, could edit their vote, and could vote for more than one option. All users could see the total number of responses and who voted for each option. Anyone on the server had access to use Simple Poll, but server administrators (instructors) limited in which channels the bot was active.

Adapting to the use of Discord, whether for synchronous online or in person classes, was initially a concern of several students—most students in every class said it was their first time using the platform. The learning curve for Discord, however, is not steep. Despite the introduction of this new application, students were able to adapt quickly and take full advantage of what Discord had to offer a biology class. In fact, two studies found their students were generally receptive to using Discord in spite of their hesitancy (1, 2). Further, this student support of the platform was reflected in their scores on English as a foreign language exams over peers who were not instructed with Discord as a tool (2). Here, some students chose to participate on Discord occasionally from their phone, allowing them greater freedom of where and when they could access the material. In this way, students could ask questions in the chat and participate in video calls, albeit with the drawback of only seeing one screen at a time. Instructors recommended that students use a computer or tablet for class work, but on occasion using a phone was acceptable. In a physical classroom, using a phone for Discord worked well because it allowed for quick and easy communication. Avoiding academic misconduct was not itself a novel problem with Discord, but to allay concerns of cheating, assignments and assessments were designed to either be group work or require higher order thinking within Bloom’s Taxonomy.

There is nothing that can be done to prevent students from electronically communicating about a class. It has been the personal experience of one of the authors (SS) that students will use a group messaging platform, like groupme (groupme.com), to create a class group chat to discuss studying. The creation of these chats appeared in every single class that this author took at Mercer University, except for courses where Discord was used by AW. It is in this regard that the ability of students to create private servers and messages within Discord is not a novel problem with this tool but exists throughout academia. Preventing cheating through Discord should not be approached differently from preventing cheating in any other class, because there are no novel cheating methods here that differ from other teaching environments. Plagiarism checkers and testing centers can be used to help mitigate plagiarism and cheating, but these approaches are beyond the scope of this paper.

Creating Community in and out of Class
In a physical classroom or lab room, students sit together to facilitate group work. The professor and TAs can give instruction from the front of the room, then allow students to work. Instructors can move about the room, checking in with students, giving help or correction, and making announcements for clarification to the class as a whole. This common space, with easy accessibility to the professor and fellow students, allows seamless communication from all parties. If utilized to its full potential, Discord can excel over other virtual platforms, such as Zoom (zoom.us), because it provides a permanent space that any member can access at any time, allowing its use to extend to multiple types of learning environments. Outside of classroom hours, the students were observed
to be using Discord to talk to each other casually about the class, send appropriate social media memes, or share various insights which built a sense of community as viewed by the authors.

Collaboration was possible through text, voice, and video chat at the students' own discretion, which could be monitored by the instructors. By using voice channels, students were also able to share screens. Although a user can only see one channel member's screen at a time, more than one user can share their screen at the same time, allowing for easy switching of views. In addition, changing what is being shared does not require users to stop sharing to switch, thereby streamlining conversation.

*Discord* allows for more supervision and guidance by the instructors because the thought process of students could be observed. *Discord* also allows instructors to intervene when necessary. Aside from watching interactions between students, *Discord* also provided a window to the nuances of being a student. Putting tasks or meetings off until near a deadline was a common practice, which was evidenced by their comments in chat, and these practices were addressed by the professor. Instructors could clearly see which students were shirking responsibilities and which were group leaders. Sometimes what was witnessed in meetings with the professor did not align with the work evident in the text chat. Students might be more outspoken when talking with the professor but not contributing much to the group work, or vice versa. *Discord* allowed the instructors to keep tabs on actual contributions.

*Discord* is not only applicable to group work or labs, but the tool can also be applied to various class formats. Here, *Discord* has been used in classes from 17 to 75, both online and in-person. Most classes have been lecture-based, heavy with active learning, and some peer discussion, but the Bioinformatics course was taught with "lecture" and "lab" combined and ranged from full class discussion to group projects. The biochemistry course does not have a joint lab, yet students used the platform outside of lecture to seek help and otherwise communicate, garnering more engagement and community in each class. The learning platform has been successfully implemented in all of these formats to the benefit of the students, TAs, and the professor. Even if there were to be a class of 5000 students, *Discord* could accommodate a voice chat involving every one of the students. Because *Discord* limits voice channel users to 20 when video is shared (discord.com), however, *YouTube* (youtube.com) was used to livestream to the class of 75 students. This limit was later circumvented by screen sharing output from the professor's camera. In addition to the uses described here, Moro et al. (3) provide examples of various other ways that *Discord* might be used in a classroom.

**Tips for moderating a Discord discussion:**
With the ability of students to post and chat online during a lecture comes the need for moderation of that chat. This need for moderation, however, can be turned to an advantage. With class sizes larger than approximately 20, it can be difficult for the professor to moderate and lecture at the same time, particularly for classes in which active learning is employed or participation from the class is desired. A TA, or perhaps a student selected each day, may moderate the text channel used during class time.

One way *Discord* moderation can be used to effect is to help students receive information from the professor and to aid them in staying on task. If the professor instructs the class to turn to a specific page or view a specific figure, this information can be repeated in the chat for students who missed it. Another way of aiding students is to post tasks on which the professor would like the class to work, or generally repeating information about which students frequently ask, such as deadlines,
key information, or requests. Not only does this keep students from interrupting the professor to ask them to repeat instructions but also it also reduces the time that students are off-task and waiting on a reply, thereby increasing their engagement. A moderator is also able to bring the class back to attention in the rare instance the chat gets off topic.

A moderator can promote engagement during class time in other ways. Emojis can be used to react to students’ comments, creating a fun and engaging way to respond. A moderator can use a bot such as Simple Poll as a means by which to poll or quiz students for understanding. In addition, a moderator can look for specific, material-based, student questions to bring to the professor’s attention. Being an active moderator can facilitate active engagement amongst students; however, without a moderator much of the same engagement can be achieved.

Mr. Simmons’s Perspective as a Student and TA:
When compared to other online courses I have taken, Discord gave me a greater sense of community and connectivity with not only my professor but my fellow students as well. It made me more comfortable to ask questions directly to my professor and to the class itself. I felt more connected to the material because I was able to access and reflect on class discussions at my own pace. I enjoyed the ability to directly message the instructors to ask specific questions that I did not feel comfortable asking in front of the class, for one reason or another.

In the two online courses I was enrolled in with Dr. Wiles, my group solely used Discord to communicate with each other. Each time we agreed on a meeting time outside of class, we wrote it down in our group Discord channel and also sent reminders to one another up until the meeting. We used the channel to keep record of insight the instructor gave us or to keep information that may have aided us in our work in a permanent space. Whenever we had meetings, the Discord channel allowed us to take notes about our topics and conclusions, keeping them safe and fresh in our minds for the next class or meeting. We were able to easily assign each other tasks and make sure the workload was fair by keeping a record of things to do and things we had done in the Discord. We commonly asked questions in our group’s channel using the @prof or @TA function, even outside of regular hours, so we would be able to get an answer to the question whenever our instructors were available rather than trying to remember the question until class started. Discord was an enjoyable way to communicate with my group members. We communicated using emojis, picture reactions, and more common text-like language than I have done in other classes. Using emojis to react and communicate built a sense of community within my group and within the entire class as well. I feel as though, as a more introverted individual, I was able to ask more questions to my instructors and peers than I normally would. The overall experience of using Discord allowed me to bond with my group members and fellow classmates.

As a TA, using Discord allowed me to be more accessible to students. Instead of being limited to one physical space in a classroom, students were able to send me a message to call me into their group voice channel or ask a question at any point during class, lab, and outside of classroom hours, allowing me to answer at my discretion. If a student had a question at 8:00 at night, they sent it, and I could answer the next morning, in class, or that very night. As a TA, I often read through each group’s text channels to get a better understanding of where they were and their thought process, so I could provide accurate insight when needed. I found this ability to be an elevating experience for the online and physical lab space. I could aid students because I understood what each group was talking about, where they were, and what help they needed. I also enjoyed the ability to send messages or updates that were pertinent to the entire class in the general lab text channel. I did not have to get everyone’s attention and shout key information out loud, which would likely be lost or
forgotten. Instead, I was able to give everyone important details that could help them in a permanent place so they could refer back to it at their own time, allowing each group to work at their own pace. I also monitored what questions groups were asking the professor, either in voice channels or in their text channels, so if there were any common questions, I could repeat their answers in the general lab text channel for the entire class.

Overall, from my perspective, there were only positives to using this platform as both a student and TA, since making a classroom more connected and facilitating a community environment are both pillars of learning that could always use improvement.

References

1. Arifianto M, Izzudin I. 2021. Students’ Acceptance of Discord as an Alternative Online Learning Media. International Journal of Emerging Technologies in Learning 16:179-195.

2. Odinokaya M, Krylova E, Rubstova A, Almazova N. 2021. Using the Discord application to facilitate EFL vocabulary acquisition. Education Sciences 11:470-482.

3. Moro G, Vermonde A, Mittelbach A, Azevedo B, Campagnolo B, Carvilhe C, Filho N, Perin M, Silla C. 2021. Using Discord as an extension of the emergency remote teaching classroom during the COVID-19 Pandemic. IEEE Frontiers in Education Conference 1-9.
| Category / Channel | Function                                                                 | Courses          |
|--------------------|---------------------------------------------------------------------------|------------------|
| **General text channels** |                                                                             |                  |
| #announcements     | Class-wide announcements from the professor or TA.                         | all              |
| #general           | Questions and discussions related to class or the material, but not during lectures. | all              |
| #lecture_chat      | Lecture specific discussions and questions. This channel was designed to take abundance of messages during lecture to keep that large number of messages out of #general so that students' comments and questions would not get lost. | online           |
| #ta_chat (private) | Communication between professors and TAs, relaying instructions or pertinent information that students could not see. | all with TA      |
| #ethics            | Discussion of ethical assignments given and cordially debating the issues presented. This is a project-specific channel. | Genetics         |
| #tech_help         | Questions regarding how to use Discord or other class-related technology. | all              |
| #off_topic         | Community building and discussions between students, TAs, and the professor that did not directly relate to class material. Memes in abundance, COVID questions, science news, and calls for participation in other campus activities. | all              |
| **General voice channels** |                                                                             |                  |
| General            | Lectures and office hours.                                                 | all              |
| TAs (private)      | Instructor and TA meeting space to communicate about the class and provide updates to each other. | all with TA      |
| **Discussion voice channels** |                                                                             |                  |
| #[discussion group] | Enough unique channels for groups of 3-4 and channel size was purposefully limited. To make it easier for students to remember their group, animal names were given to them, along with a corresponding emoji to be used in chat. | Genetics         |
| **Peer-review voice channels** |                                                                             |                  |
| #[peer review group] | Enough unique channels for each peer review group to talk during lab. Peer review is done in groups different from lab groups. Because different lab sections used these at different times, fewer needed to be made. These were separate from discussion group channels for student clarity. | Genetics         |
| **[Section] text channels** |                                                                             |                  |
| #[lab_group]       | Each lab group had its own, named text channel to facilitate communication within the group and to provide a place to ask questions of the instructors and keep a record of the conversations. | all with lab     |
| **[Section] voice channels** |                                                                             |                  |
| [lab group]        | Each lab group had its own, named voice channel, corresponding to their text channel, where they could meet during class and outside of class hours, if needed. | all with lab     |
| **Feedback text channels** |                                                                             |                  |
| #[lab_group]       | Each lab group had its own, named text channel where text feedback could be received, providing a comprehensive and permanent record of feedback, not interfering with other aspects of the class. | Bioinformatics   |

Table S1. *Discord channels created*