ARTICLE Undergraduate Learning Assistants Using Online Messaging Improves Student Educational Experiences in Large Neuroscience Lecture Courses.

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This study investigated the impact of undergraduate learning assistants on students' educational experiences in large lecture neuroscience courses. These courses were highly structured and incorporated weekly assignments codeveloped with undergraduates trained in a Certified Learning Assistants Program (CLAP). We employed four undergraduate learning assistants (LAs) in two large lecture general education neurobiology courses who assisted the instructor in developing targeted homework assignments based on lecture content. Students were encouraged to interact with LAs via email, Canvas, or an online messaging platform. The messaging platform did not include the instructor or graduate student teaching assistant (TA). LAs provided weekly in-person homework assignment introductions and review sessions during lectures. At the end of the course, students answered surveys about their learning experience, communication preferences, and overall sense of belonging. Findings suggest that the incorporation of undergraduate learning assistants improved students' sense of belonging and confidence in large lecture neuroscience courses. Students were more comfortable asking content questions of LAs in a collaborative group messaging chat without graduate TAs or the Instructor. Group chat communications were preferable to using their course Canvas site or traditional email. Student interest in the course was increased by knowing that the course assignments were generated by the undergraduate LAs. Although students felt that LAs improved their sense of belonging, they were still less comfortable interacting with LAs in person compared to online platforms. In summary, LA involvement provided effective peer support for students and student perspective for the instructor, increasing students' sense of belonging and interest in course content.

Key words: undergraduate learning assistant (LA); sense of belonging; large lecture; online messaging; peer support

The integration of learning assistants (LAs) in large lecture courses is conducive to improved educational experiences for students (Clements et al., 2022; Carlos et al., 2023). The LA model uses undergraduate-level peer educators or junior teaching assistants who receive specialized training and certification through programs like the Certified Learning Assistants Program (CLAP) (Certified Learning Assistants Program [CLAP], 2024). CLAP, offered by the university's Division of Teaching Excellence and Innovation, is a tenweek pedagogy course enrollable by undergraduates and covered by tuition. This program teaches practical strategies that help LAs to facilitate collaborative group work with an emphasis on active learning.

In order to be an LA, our undergraduates must be certified by completing the CLAP course. They then enroll as an LA in the course they wish to support with instructor approval and earn a grade. LAs differ from traditional graduate teaching assistants (TAs) because they typically work in the classrooms alongside the instructor, providing a peer-led approach to promote student collaboration during active learning that encourages discussion and poses open-ended questions that draw out students' reasoning rather than simply offering further instruction or clarification (Otero et al., 2006; Learning Assistant Alliance [LAA], 2020). Thus, LAs receive no monetary compensation, but do receive graded course credits, early pedagogy experience and the opportunity to put their training into practice under the supervision and continued pedagogical mentorship of a faculty member.

Current research demonstrates a variety of positive impacts of LAs on the student educational experience. Studies suggest using LAs in undergraduate courses can improve students' sense of belonging, confidence, performance, and overall understanding of course material (Talbot et al., 2015; Sellami et al. 2018; Clements et al., 2022). Such benefits may result partly from the inherent relatability and approachability of LAs as peer educators (Hernandez et al. 2021; Luckie et al., 2020). The demographic commonalities between LAs and students may also serve to lessen the disconnect the students feel because of the traditional power dynamics established between the student and instructor within the higher educational setting (Clements et al. 2022). As a result, LAs lessen the potential for intimidation and promote learning, especially for under-represented groups in STEM (Brady et al., 2020; Van Dusen and Nissen, 2020; Clements et al., 2022). LAs improve students' comfort by facilitating participation in the active learning process and serving as intermediates who can field students' questions and seek clarification from instructors.

The roles of LAs in our classes were threefold: to uphold the evidence-based pedagogical methodologies set forth by CLAP, to provide a peer-informed perspective in the development of course activities, and to interface directly with students both in person and through the online messaging platform. The use of LAs in the design process for course activities is a novel aspect. Following lectures, LAs provided real-time feedback to the instructor, including concepts and information that needed further reinforcement. This feedback informed the creation of targeted weekly course activities in addition to gauging lecture pace and content reception.

During lectures, LAs were strategically positioned throughout the classroom to facilitate active learning. After the instructor posed a problem to the lecture hall based on presented materials like charts, cases, or mechanisms, LAs circulated among students, fielding their individual questions, providing clarification and guiding their reasoning. This real-time support allowed LAs to identify common points of confusion and provide immediate assistance without disrupting the lecture flow. LAs would signal to the professor if multiple students were struggling with a particular concept, enabling timely clarification for the entire class. For instance, during an activity they may approach the instructor and say, "A lot of students are confused about what amygdala "excitation" really means" or "That group seems to think that a voltage-gated channel is the same thing as an ion channel and so they don't get why the glutamate ligand-gated channel is also an ion channel" The instructor could then address the confusion as a class immediately. This dynamic interaction between LAs and students and daily presence in the lecture created an engaging learning environment and gave support throughout the learning process, providing the opportunity to reinforce key concepts and administer timely feedback to students (Otero et al., 2015).

Another novel use of LAs involved maintaining an instructional presence outside the classroom by utilizing an online messaging forum that excluded the course instructor and graduate TA. Such digital safe spaces provided additional opportunities for students to engage with LAs, ask questions, and participate in peer-led discussions, providing a more inclusive, convenient, and contemporary communication style. In addition, given the increased volume of students' questions in large lecture settings, this platform had the added benefit of allowing LAs to lessen the burden of repetitive and non-urgent questions directed to the instructor regarding course content or assignments.

The present study aimed to assess the usefulness of LAs in two large undergraduate general education neurobiology lecture courses and the impact of peer-informed activity design on perceptions of learning, sense of belonging, and overall educational experience. By examining students' perceptions and engagement with LAs and their activities both inside and outside of the classroom, this research sought to contribute to the growing body of knowledge on effective communication strategies for enhancing student learning and fostering an inclusive and supportive academic environment.

MATERIALS AND METHODS

Course Description

This study was conducted in two large, lower-division neurobiology courses, a fall quarter neuropharmacology course and a winter quarter course on the neuroscience of mood disorders. Both courses were available to all nonbiological science majors (meaning all biology majors, including neuroscience majors, were not allowed to take either course). Neither course had prerequisites, and both fulfilled the university's general education science and technology requirements. Each 10-week course provided a foundational overview of neurobiology topics for a primarily general education student population, with enrollment restricted to non-biological science majors. The course assessments included weekly assignments, weekly takehome practice quizzes, and three in-person multiple-choice exams.

Instructional Team

Each course utilized an instructional team comprising one instructor, one graduate TA, and four CLAP-certified LAs. The certification process, run by the university's Division of Teaching Excellence, signifies the LAs' completion of specialized pedagogical training, equipping them with the necessary professional skills to lead and facilitate course discussion. In addition, the LAs had completed at least two upper-division neurobiology courses. Sixty-seven percent of LAs described their gender identities as female and thirtythree percent as male.

Student Demographics

There were 247 students enrolled in the mood disorders course and 337 in the neuropharmacology course. Student surveys from the neuroscience of mood disorders course revealed the following demographic information: A total of 24 majors were represented, with most students (70%) declaring a psychology major (Supplemental Figure 1). 74% of students described their gender identities as female, 23% as male, and 3% as non-binary/3rd gender. Student standing results showed 15% freshmen, 18% sophomores, 42% juniors, and 25% seniors. The students' ages ranged from 18 to 42, with a mean of 20 years of age. Demographics were not available for the neuropharmacology course.

Activity Information

LAs played a key role in developing and implementing supplementary learning materials for students. As a core component of this support, LAs created targeted pre-lecture worksheets that helped students engage with course content. The number of worksheets (eight for neuropharmacology and six for mood disorders, available as *supplementary material 1 and 2*) was targeted to the pace and progression of the corresponding courses' lecture series. To ensure worksheet effectiveness, LAs actively participated in lectures while taking detailed notes, identifying concepts that students found challenging and areas that required additional practice and review. LAs collaboratively created worksheet activities utilizing lecture material, personal content experience, and published neuroscience content material. This drafting process intentionally utilized various levels of Bloom's Taxonomy (Bloom et al., 1956) to foster higher-order thinking and promote deeper understanding by engaging students in activities ranging from basic knowledge recall to critical analysis, complex problem-solving, and evaluation. More specifically, the weekly activities incorporated diverse question types that assessed general neuroanatomy and function, neurotransmitter signaling pathways, relevant scientific literature and articles, graphs and data, and the application of course concepts to real-world scenarios. These worksheets have been included as supplementary materials in this manuscript (Supplemental Figures 2-3).

Following the development of weekly activities, drafts would undergo review and revision by the course instructor to ensure alignment with the instructor's vision before ultimately launching the activity to the class. This collaborative drafting scheme served as a mechanism to enhance the quality of the assignments and to encourage LAs to explore different pedagogical approaches that might contribute to the educational experience. LAs introduced each of the finalized activities in a brief in-class presentation to establish expectations for the activity and address preliminary concerns from students. Additionally, after each activity's completion, LAs would lead a follow-up review session, providing answers and facilitating open discussions with students to provide clarification and further feedback.

Importantly, LAs did not have access to the course grades or exam information, preventing students from seeking special treatment and maintaining the academic integrity of this process. By incorporating LAs into the process, the instructional team aimed to create accessible activities that were more relevant and engaging, reflecting an authentic student perspective while addressing the course's educational objectives.

LA-Student Interfacing

LAs maintained a multifaceted role in providing both inperson and virtual support to students throughout the course. The in-person responsibilities of LAs included reviewing worksheets that LAs had developed and walking around the classroom during lectures to field and answer any student questions. Their virtual responsibilities included responding to student inquiries and offering assistance via multiple platforms, such as email, the course management system (Canvas), and an established online messaging platform (Discord). Discord is a free online application that lets users communicate with each other through text, voice, and video. This messaging platform, exclusive to students and LAs, created an informal environment for open communication without the presence of TAs or instructors. However, this does not mean that information passed through this channel was entirely outside the instructor's radar. LAs in this platform helped to lessen the burden of non-urgent or repeated logistical questions on the instructor, a common challenge in large lecture settings, and to filter and relay collective concerns from the student population directly to the instructor.

Data Collection

Students were asked to complete an anonymous survey at the end of each course using a Google form developed by the instructional team for two extra credit points (Supplemental Figure 4). In the neuropharmacology course, 284 students out of 337 completed the survey. In the neuroscience of mood disorders course, 198 out of 247 completed the survey. The survey assessed student experience with LAs in large classroom settings, whom students were most comfortable approaching with questions, which platforms of communication they preferred, and their sense of belonging in the class. The survey questions employed a quantitative numeric Likert scale (1 low, 10 high) and multiple-choice questions. All results were pooled by percent student response.

RESULTS

Students' opinions and preferences for LA assignments were assessed. Results suggested that most students believed that the LA assignments were the right length (91.70%), with the majority of students spending 1-2 hours per week completing the LA assignments (Figure 1). Results also suggested that most students felt that knowing that the LAs had developed the worksheets made them somewhat more interesting (Figure 2).



Figure 1. Time spent on LA assignments. The majority of students reported that they spent between 1-2 hours per week on LA assignments. Mean=1.82 hours. n=284 for Mood Disorders and n=198 for Pharmacology.

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Figure 2. Interest level in resources made by LAs. Students reported worksheets were more interesting because LAs made them. n=284 for Mood Disorders and n=198 for Pharmacology.



Figure 3. Likelihood of asking questions with LAs. Students reported having LAs walk around the classroom made them slightly more likely to ask questions (mean=6.56 on a 10-point scale). Class approachability with LAs. Students reported having LAs made the class more approachable (mean=8.41 on a 10-point scale). Feeling of sense of belonging with LAs. Students reported LAs made them feel a higher sense of belonging in the classroom (mean=7.75 on a 10-point scale). n=284 for Mood Disorders and n=198 for Pharmacology.

Results suggested that having LAs walk around the classroom made students slightly more likely to ask questions. Results also suggested that LAs made the class more approachable and increased students' sense of belonging in the classroom (Figure 3).

The survey also suggested that most students preferred asking questions through an online messaging platform (Discord) as opposed to email and Canvas. They also preferred to ask the LAs questions rather than the graduate TA and/or professor. Results showed that more students preferred a forum with only LAs and students that excluded the graduate TAs and Instructors (Figure 4). When asked to explain their preferences, some students reported that they felt communication would be hindered by the presence of the graduate TA and/or professor (33.20%).





Figure 4. Preferred messaging server. Students reported that they prefer having group messaging with only LAs and other students, not observed by the graduate TA or professor. n=284 for Mood Disorders and n=198 for Pharmacology.

DISCUSSION

This study highlights the positive impact of Learning Assistants (LAs) on students' educational experiences in large undergraduate neurobiology courses for nonbiological sciences majors. Similar to findings in a recent study involving LAs in large STEM lecture series (Clements et al., 2022), students felt more comfortable asking questions and interacting in class with the presence of LAs in both large lecture courses.

Moving online, most students preferred LA-exclusive messaging platforms instead of ones that included the instructor or TA. Interestingly, this finding highlights the under-studied value of platforms catered exclusively to students and LAs alone. The integration of messaging platforms in higher education classrooms has been shown to increase information and knowledge exchange between students and educational staff (Heinrich et al., 2022). Our study extends these findings by revealing students' preferences for whom they communicated with through similar platforms. This preference for LA-exclusive messaging platforms suggests their potential as a novel avenue to improve student support and engagement beyond typical means. Moreover, while traditional studies have focused on the in-person benefits of LAs (Otero, 2015), the results of this study support the idea that leveraging peer-to-peer digital communication can supplement the typical impersonality of large lecture environments (Morra et al., 2022).

The quick feedback provided by LAs via online messaging may also benefit instructors by offering insights into student misconceptions and areas of confusion as they occur. Information provided by the LAs on these platforms allowed for timely and effective adjustments to course delivery and highlighted areas that would benefit from further instructor attention and review. Thus, not only can LAs field student questions promptly, but relaying those questions back to the instructor can stem the development of misconceptions. Providing a first pass at student questions can also prevent instructors from being overwhelmed by non-urgent, repeated, or LA-answerable questions from students. Further, a greater magnitude of student response may be gleaned from LA peers who don't hold authority as a traditional graduate TA or control over aradina.

It should be noted that Discord is not the only messaging platform that can be used for communication between LAs and students. Similar platforms that possess open forum capabilities are just as capable of supporting similar interactions and subsequent outcomes. We decided to use Discord solely because it was the platform that students at our institution were already using to coordinate their own class chats.

LAs also appear to enhance the approachability of large lecture courses and contribute to a greater sense of belonging among students. A stable sense of belonging has been shown to potentiate career satisfaction and success, psychological well-being, community involvement, and leadership (Brady et al., 2020). LAs can bring novel ideas into the classroom to better support their fellow undergraduate students from an informed perspective of discipline-based best practices. Further, a greater magnitude of student response virtually and in the classroom may be gleaned from LA peers who don't hold authority as a traditional graduate TA or control over grading.

The peer-designed activities developed concurrently with instruction were particularly well-received, as they tended to align more with student needs and level of understanding. In addition, while reviewed by the instructor, LA input provided a fresh take on course content from a student's perspective. The peer-generated nature of these assignments made the content more relatable and engaging, perhaps contributing to a higher level of student interest in the course material. This finding is consistent with prior research indicating that peer-assisted learning strategies can lead to greater cognitive and affective engagement in academic settings (Kornreich-Leshem et al., 2022).

The prerequisite CLAP course for prospective undergraduate LAs provides an introductory framework that will serve them in future careers that require mentorship and instruction. LAs who serve in the classroom are enrolled in continued pedagogical instruction under a faculty supervisor for a grade. The course therefore provides LAs experience in the classroom, mentorship and perhaps even a pedagogy research project like the one you are now reading. Not all institutions have established LA development programs. Interested faculty should inform themselves about policies specific to their institution regarding undergraduate assistance in an undergraduate classroom before embarking since the allowable responsibilities of an undergraduate assistant can differ significantly from those of a graduate student assistant.

Overall, our study highlights the innovative use of peerdesigned activities and digital platforms to expand the involvement of LAs in large neurobiology courses for nonmajors. While traditional graduate TAs have long supported students in discussion sections, our findings suggest a degree of intimidation that may be dispelled by using a peerto-peer approach. Although our study did not specifically examine undergraduate teaching assistants or supplemental instructors, their shared undergraduate status suggests they may similarly benefit from the peer connection we observed to be influential in reducing intimidation and fostering engagement. This approach has proven effective in making undergraduate neurobiology courses more approachable and engaging for students, enhancing their educational experience. Future research should explore the scalability and feasibility of this model across different disciplines and class formats to fully understand the potential of undergraduate learning assistants and digital peer-assisted learning environments in different educational contexts.

REFERENCES

Bloom, BS (1956) Taxonomy of Educational Objectives, Handbook: The Cognitive Domain. New York, NY: David McKay Company, Inc.

- Brady, Shannon (2020) A brief social-belonging intervention in college improves adult outcomes for black Americans. Science Advances 6: 18. doi:10.1126/sciadv.aay3689
- Carlos CML, Maggiore NM, Dini V, Ćaspari-Gnann I (2023) Characterizing facilitation practices of learning assistants: an authoritative-to-dialogic spectrum. IJ STEM Ed 10: 38. doi:10.1186/s40594-023-00429-4
- Certified Learning Assistants Program [CLAP] (2024) *Learning Assistants*. Available at

https://dtei.uci.edu/opportunities/faculty/learning-assistants/.

- Clements TP, Friedman KL, Johnson HJ, Meier CJ, Watkins J, Brockman AJ, Brame CJ (2022) "It made me feel like a bigger part of the STEM community": Incorporation of Learning Assistants Enhances Students' Sense of Belonging in a Large Introductory Biology Course. CBE Life Sci Educ. Jun;21(2):ar26. doi:10.1187/cbe.21-09-0287
- Heinrich E, Thomas H, Kahu ER (2022) An exploration of course and cohort communication spaces in Discord, Teams, and Moodle. Australasian Journal of Educational Technology: 38(6), 107–120. doi:10.14742/ajet.7633
- Hernandez D, Jacomino G, Swamy U, Donis K, Eddy S (2021) Measuring supports from learning assistants that promote engagement in active learning: evaluating a novel social support instrument. IJ STEM Ed 8: 22. doi:10.1186/s40594-021-00286-z
- Kornreich-Leshem H, Benabentos R, Hazari Z, Potvin G, Kramer, L (2022) The cognitive and affective roles of learning assistants in science, technology, engineering, and mathematics college classrooms: An exploration of classroom experiences and students' metacognitive awareness and disciplinary identity. Science Education: 106. doi:10.1002/sce.21703
- Learning Assistant Alliance [LAA] (2020) LASSO: Learning About STEM Student Outcomes. Available at

https://learningassistantalliance.org/public/lasso.php.

- Luckie DB, Mancini BW, Abdallah N, Kadouh AK, Ungkuldee ACP, Hare AA (2020) Undergraduate teaching assistants can provide support for reformed practices to raise student learning. Advances in Physiology Education, 44(1), 32–38. doi: 10.1152/advan.00090.2019
- Morra CN, Fultz R, Raut SA (2022) A Lesson from the Pandemic: Utilizing digital tools to support student engagement during instructional assistant-led sessions. J Microbiol Biol Educ: 23(3):e00143-22. doi:10.1128/jmbe.00143-22
- Otero V, Finkelstein N, McCray R, Pollock S (2006) Professional development. Who is responsible for preparing science teachers? Science. Jul 28;313(5786):445-6. doi: 10.1126/science.1129648.
- Otero V (2015) Nationally scaled model for leveraging course transformation with physics teacher preparation. Recruiting and educating future physics teachers: Case studies and effective practices, 107-116.
- Sellami N, Shaked S, Laski FA, Eagan KM, Sanders ER (2018) Implementation of a learning assistant program improves student performance on higher-order assessments. CBE—Life Sciences Education. 16(4): 1–10. doi:10.1187/cbe.16-12-0341
- Talbot RM, Hartley LM, Marzetta K, Wee BS (2015) Transforming Undergraduate Science Education With Learning Assistants: Student Satisfaction in Large-Enrollment Courses. Journal of College Science Teaching 44(5): 24–30.
- Van Dusen B, Nissen J (2020) Associations between learning assistants, passing introductory physics, and equity: A quantitative critical race theory investigation. Physical Review Physics Education Research. 16(1): 010117. doi: 10.1103/physrevphyseducres.16.01

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