2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #51677

Work-in-Progress: The Role and Impact of Undergraduate Instructional Aides in Robotics Education

Dr. Xiaoxiao Du, University of Michigan

Xiaoxiao Du is a Lecturer at the University of Michigan. She teaches robotics courses and supervises multidisciplinary teams and design experiences. She is interested in promoting student learning and team collaboration through innovative curricular design and data-informed evaluation.

Work-in-Progress: The Role and Impact of Undergraduate Instructional Aides in Robotics Education

ABSTRACT

This work in progress paper presents an exploratory study that investigates the roles and impacts of undergraduate Instructional Aides (IAs) in robotics education, focusing on case studies from two undergraduate robotics courses at a large Midwestern university. While graduate and undergraduate students are commonly employed as instructional support staff – gaining valuable experience, helping to meet instructional demands, and controlling university costs – priority is often given to graduate students due to funding and professional development considerations. However, undergraduate IAs, if intentionally recruited and organized, may bring unique strengths and form highly effective student instructional teams. In this work, we examine instructional teams from a first-year, hands-on robotics course and an upper-level human-robot interaction core course. Robotics was selected as a context due to its multidisciplinary, project-intensive nature, which places high demands on instructional aides and student staff. This research incorporates both student feedback and IA perspectives, acknowledging the diverse backgrounds of IAs from recent course alumni to experienced aides, some of whom transition to graduate instructional roles.

Key research questions include: Do students find undergraduate IAs more approachable or helpful than graduate student aides in hands-on settings? How does the presence of undergraduate IAs influence students' classroom experiences? Additionally, how does serving as an IA impact the aides' own professional development, teaching confidence, and career aspirations in STEM fields? By presenting and analyzing both qualitative and quantitative feedback from students and IAs in these courses, this work seeks to understand the undergraduate IA's perspectives in several aspects of the IA roles, including their experience, preparation, interactions, professional development, team dynamics, and support. We hope the initial findings and observations will inform future recommendations for the recruitment, training, and support of IAs in robotics and other technical disciplines, with the broader goal of enhancing learning environments, mentorship, and educational outcomes within engineering curricula. This study also aims to initiate a discussion on enriching both student and IA experiences while contributing valuable insights to the ongoing discourse on peer-assisted teaching in STEM education.

INTRODUCTION

While graduate students are traditionally prioritized for instructional support roles [1] [2], the intentional recruitment and organization of undergraduate instructional aides (IAs) may bring

new strengths and foster highly effective student-centered teams. Undergraduate IAs offer unique insights owing to their recent engagement with course material and their peer proximity to students. When intentionally recruited and appropriately trained, they can bridge gaps in understanding that instructors and graduate students may overlook [3]. Their relatability and firsthand experience with current curriculum and instructional approaches can foster an atmosphere of trust and camaraderie in the classroom, encouraging students to seek help and engage especially in active learning settings [4].

Many strategies have been proposed to promote student-centered learning, such as active learning, project-based learning, flipped classroom, etc. Peer Instruction (PI) is an active learning pedagogy in which students actively participate in their own learning by discussing questions with small groups of peers during class and providing real-time feedback to the instructor. Multiple platforms and tools have also been developed to promote learning through peer instruction such as a peer-to-peer (P2P) learning platform [5], a platform for Agile software design principles [6], and printed or online polls [7]. However, in much of the previous PI literature, the focus was on the P2P platform, pedagogical or instructional methods, or ways for class to participate (e.g., flashcards, polls, etc.). In this work, we seek to study student-centered learning from the instructional staff's perspective. Instead of platforms and technologies, we focus on the people – the undergraduate IAs, to be specific. We explore the roles and impact of including undergraduate students as teaching staff, how the roles of IA impact their own learning and their career confidence, as well as the interactions with IAs from a student's perspective.

Through analyzing qualitative and quantitative feedback from students who both served as student and IAs in two robotics courses, this exploratory study seeks to examine the impact and effectiveness of undergraduate Instructional Aides (IAs) in robotics educational context. We find that the undergraduate IAs can contribute to more approachable interactions with the students. Serving in an IA role also has positive career and personal impact, including raising confidence and interest in teaching. Being an IA also helps forming strong ties and collaborations with the instructional team, as well as recognizing a gap in technical knowledge. When thoughtfully trained and well-integrated, these undergraduate teaching assistants and IAs have the potential of helping create a collaborative atmosphere in which students feel more comfortable seeking assistance, thus promoting active learning and deeper connections.

STUDY CONTEXT

The course context studied in this paper includes two robotics courses at a large Midwestern university. The first course (Introduction to Algorithms and Programming, referred to as *Course1*) is offered as a first-year introductory course for programming and algorithms. The course contains five robotic programming projects throughout the semester, where the students work hands-on with the instructional team on programming a real-world two-wheeled robot. The

learning objectives include programming in C++ and Python programming languages, as well as algorithmic methods in artificial intelligence, machine learning, and robotics such as autonomous navigation, image recognition, and path planning. Typically, the instructional team consists of 1-2 faculty members, 1 graduate staff (graduate student instructor), and multiple undergraduate instructional assistants (IAs). The role and responsibility of the undergraduate IAs for *Course1* is hosting office hours, helping debugging software (code and programming) issues, helping maintaining hardware (e.g., the wheeled robot platform), and helping with grading. The second course (Human Evaluation of Robots, referred to as *Course2*) is offered as a third-year robotics core course in human robot interaction. The course discusses user study and research methods in human robot interaction, and the labs and project assignments are much more interactive. As an example, a typical lab would consist of setting up one or more robot platforms (e.g., the Miko social robot). Students would then form into teams and design a scenario of interaction with the robot platforms (e.g., a group conversation). The students would then observe and document the interaction using qualitative and quantitative measures, such as interview, surveys, statistical methods, etc. to evaluate and report the interactions. Typically, the instructional team consists of 1-2 faculty members, 0-1 graduate student instructor, and multiple undergraduate instructional assistants (IAs).The role and responsibility of the undergraduate IAs for *Course2* includes hosting office hours, setting up robotic platforms and interaction scenarios, helping the students in general during lab time, and helping with grading as needed. The detailed similarities and differences between the two courses can be found in the Appendix.

METHOD

The research questions that we wish to investigate in this study includes:

RQ1: Do students find undergraduate IAs more approachable or helpful than graduate student aides in hands-on settings?
RQ2: How does the presence of undergraduate IAs influence students' classroom experiences?
RQ3: how does serving as an IA impact the aides' own professional development, teaching confidence, and career aspirations in STEM fields?

To answer these research questions, an exploratory study was conducted. Quantitative and qualitative questions were shared with the undergraduate staff members serving in the past two academic years (2024, 2025) on both courses. No identifiable information was collected during the process. The questions were grouped into three parts, the first asking about their experience as a student in the robotics courses (e.g., "as a student, do you find undergraduate IAs approachable/helpful/more knowledgeable in *Course1* or *Course2*", etc.) The second part asks about their experience as an undergraduate IA (e.g., self-evaluated approachability, helpfulness, training and support, etc.) when serving as instructional staff in *Course1* or *Course2.* The third part asks about their experience in other non-robotics and non-engineering courses.

Quantitative data, in the form of a 7-point Likert scale, was asked in terms of approachability and helpfulness, peer connection and comfort, academic support, mentorship and guidance, and impact. Three relevant items were given within each topic. Qualitative (open-ended) responses were sought in terms of roles and experience, training and preparation, interaction and impact, professional development, and challenges and support. Note that for this exploratory study, we only limit to the previous IAs that have both been a student in the class and served as IA on either course, as we aim to explore their self evaluation from a student's perspective as well as from an IA's perspective. Out of a total number of 9 IAs from both classes eligible, three (3) responses were received and analyzed.

QUANTITATIVE RESULTS

As a student

Five topic areas were identified and asked regarding a student's experience with undergraduate instructional aides, (1) approachability and helpfulness, (2) peer connection and comfort, (3) academic support, (4) mentorship and guidance, and (5) impact and recommendations. Within each topic area, three questions were asked on a 7-point Likert scale (1- Strongly Disagree 2- Disagree 3- Slightly Disagree (or Somewhat Disagree) 4- Neither Agree nor Disagree (Neutral midpoint) 5- Slightly Agree (or Somewhat Agree) 6- Agree 7- Strongly Agree). The question stem reads, "As a student, do you find undergraduate IAs _____ than graduate student aides." The texts in the x-axis in the following figures show the question variations for each topic area.

Figure 1-5 shows the Likert scale responses for each of the questions across all topic areas. To evaluate the internal consistency of the questions, Table 2 in the Appendix shows Cronbach's alpha for the quantitative questions across the five aspects of undergraduate IA experience from the student perspective. As shown, the "Approachability and Helpfulness" topic received a negative Cronbach's alpha score, possibly due to the limited sample size or that the questions may have reversed coding. Upon inspecting Figure 1, we observed that as a student, the responses ranked the IAs are neither more or less approachable than graduate staff, specific for *Course1* and *Course2* (2 out of 3 selecting neutral midpoint), whereas all persons ranked some degree of "disagree" in terms of "more knowledgeable" (in other words, all responses found the undergraduate IAs less knowledgeable in varying degrees than graduate staff). In terms of peer connection, the responses in general marked that undergraduate IAs were easier to relate to, but mostly neutral in terms of supporting the overall classroom environment. The "academic support" topic received a high 1.00 Cronbach's alpha value, an initial indicator that the three questions asked correlate with each other well and does measure the same construct (in this case, academic support and knowledge about the course material). The "mentorship and guidance" topic area also received a good reliability score of 0.83, and there was a general consensus that the undergraduate instructional aides offered more helpful suggestions about courses and

curriculum, and a diverse opinion about mentorship guidance in terms of jobs, internships, life, and career, possibly due to the individuality of the IA experience (e.g., for example, some people may have interacted with an IA that offered great advice on internship, but some may have missed such interactions, or interacted with another IA without internship experience, and thus unable to offer guidance or advice). Lastly, again from a student perspective, the responses seem mostly neutral about the presence of IAs as part of the learning experience, with a small percentage of the response favorably leaning towards "would recommend more undergraduate IAs".

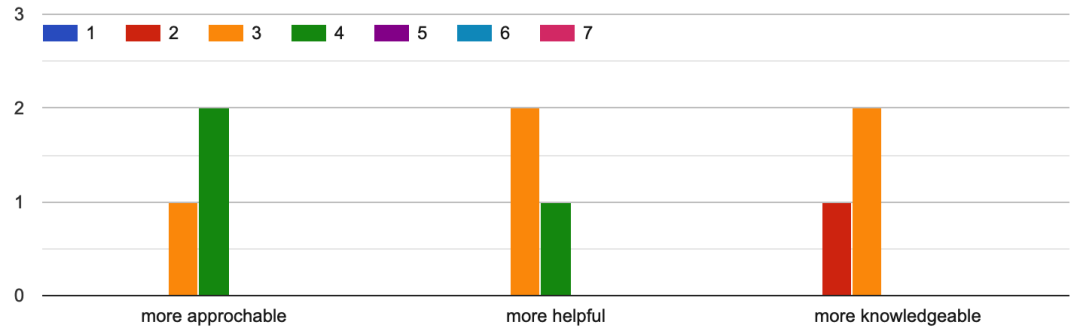

Figure 1: Likert scale response for topic "approachability and helpfulness".

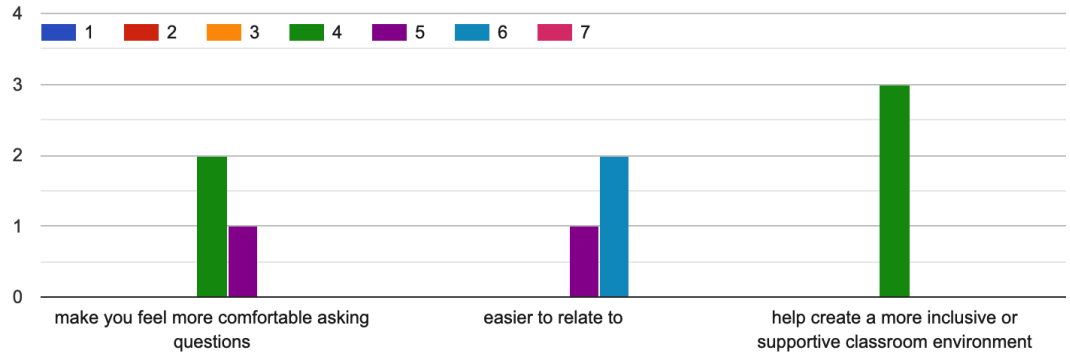

Figure 2: Likert scale response for topic "peer connection and comfort".

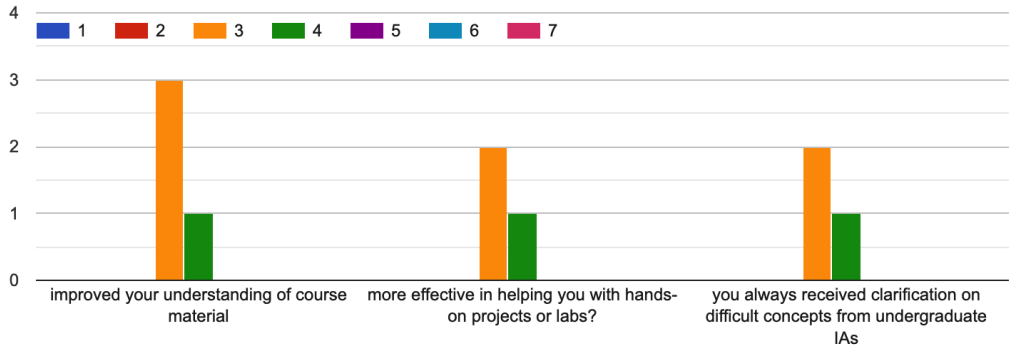

Figure 3: Likert scale response for topic “academic support”.

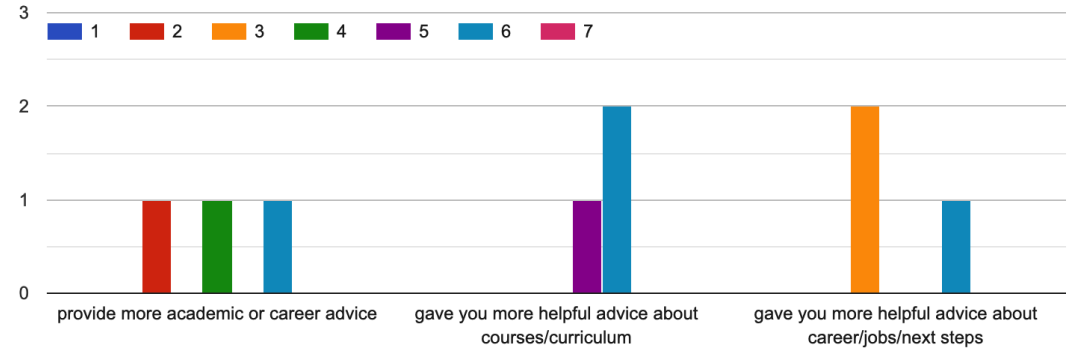

Figure 4: Likert scale response for topic “mentorship and guidance”.

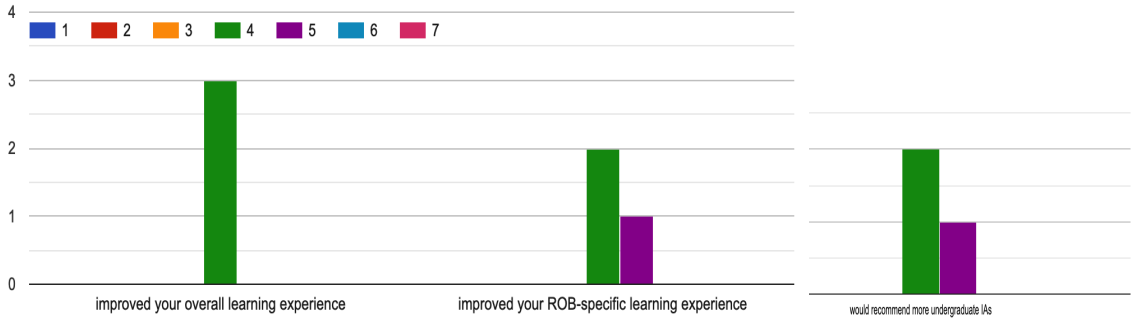

Figure 5: Likert scale response for topic “Impact and recommendations”.

As an IA (self-rated)

Figure 6 shows the self-rated results for those serving/served as undergraduate IAs in either *Course1* or *Course* 2. We asked the IAs to self-rate in 12 questions ranging from classroom support, self-evaluation of their teaching approach, any skills gained (communication, leadership, technical, teamwork, conflict handling, etc.) As shown, in this figure, the majority of the responses are leaning towards “agreeing” (Likert scale score 5 and above). One response stated slightly disagree (yellow bar, subfigure for question (9)) in terms of handling conflict, possibly due to missed opportunity to handle conflict (e.g., another staff member already handled it) or simply due to a smooth semester (lack of significant conflict situations). We observe significantly high score (score 7) in four out of the twelve questions (3, 4, 10, 11), showing that based on the self-evaluation of the working IAs, they are confident that the IA experience improved their communication skills and adaptability in terms of teaching approach, and would recommend this experience to other students (indicating a positive working experience).

Another interesting point is in comparison to the students’ perspective in the previous section, as an IA, the self-rated responses ranked higher than when the responses were from a student’s

perspective in terms of offering helpful academic or career advice. This may indicate a mismatch between the "giver" and the "receiver". From the undergraduate staff's perspective, the responses agree (or strongly agree) that they gave helpful advice. However, from a student's perspective, while there was recognition that IAs were helpful for courses and curriculum guidance (Figure 4 above), as students they generally ranked undergraduate IAs as providing less academic or career advice. This discrepancy may be worth considering as we think about undergraduate IA training and responsibilities – Should/Could undergraduate IAs give better academic and career advice? What advice can staff members give so that the students on the receiving end would feel a stronger sense of mentorship and guidance? Do students naturally rely on more senior persons (e.g., graduate staff or faculty, or counselors/advisors) for mentorship and guidance? These questions do not have a full answer yet based on the current data, but these preliminary results may offer a starting point to investigate the relationship between staff standing (e.g., graduate versus undergraduate), academic and mentorship role, and the relationship between power dynamics and perceived helpfulness.

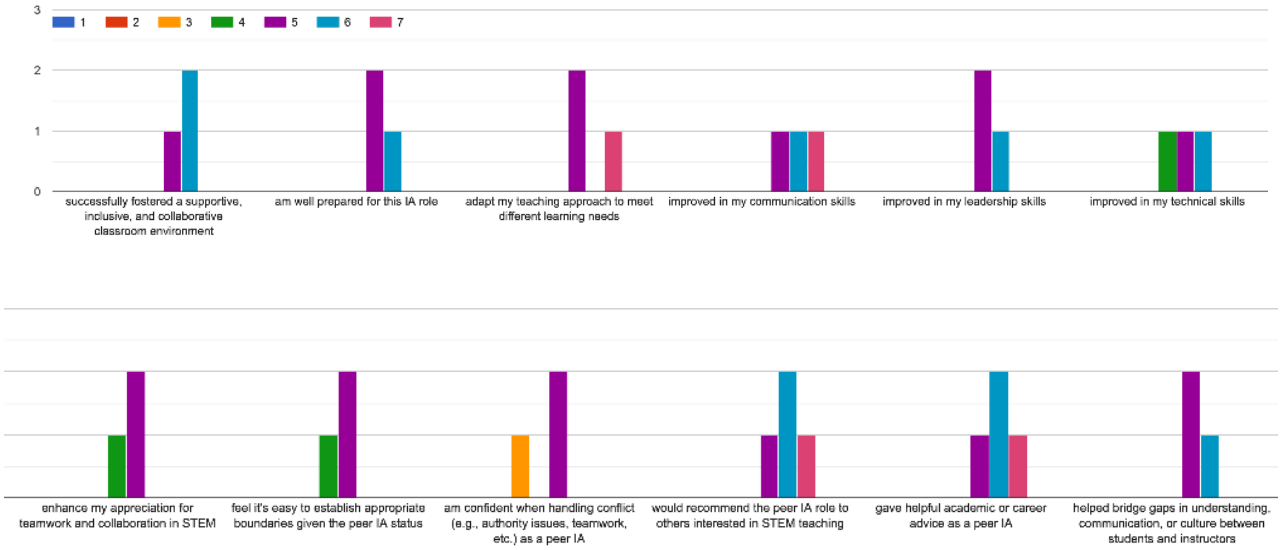

Figure 6: Self-rated Likert scale response serving as undergraduate IAs. The sub-questions include (1) successfully fostered a supportive, inclusive, and collaborative classroom environment, (2) am well prepared for this IA role, (3) adapt my teaching approach to meet different learning needs, (4) improved in my communication skills, (5) improved in my leadership skills, (6) improved in my technical skills, (7) enhance my appreciation for teamwork and collaboration in STEM, (8) feel it's easy to establish appropriate boundaries given the peer IA status, (9) am confident when handling conflict (e.g., authority issues, teamwork, etc.) as a peer IA, (10) would recommend the peer IA role to others interested in STEM teaching, (11) gave helpful academic or career advice as a peer IA, (12) helped bridge gaps in understanding, communication, or culture between students and instructors. Top row: (1)-(6). Bottom row: (7)-(12). Same color bar and Likert scale legend as previous figures.

For Other Courses

Figure 7 shows the bar-chart visualization of the responses perceiving undergraduate IAs for other robotics, engineering and non-engineering courses. As shown, for other robotics courses (but not *Course1* or *Course2*, top row), the general responses rated the undergraduate IAs as more approachable (question (1)) and helps the student feel more included or comfortable participating (question (6)), but less knowledgeable in terms of robotics concept. For non-robotics engineering courses (middle row), one person ranked "strongly agree" and the other persons ranked "slightly or somewhat agree" to the IAs being more effective with hands-on labs and projects. For non-engineering courses (bottom row), there is a wide range of responses in terms of helpfulness (from slightly disagreeing to agreeing undergraduate IAs were more helpful, question (2)).

The conclusions we can draw at the current stage of surveying are limited by the data size and the responses available. However, we can start to see some trends based on these preliminary data. Overall, for non-*Course1*, *Course2* courses (all other courses in general), undergraduate IAs were rated as more approachable (neutral, slightly agree, or agree, question (1), addressing RQ1) and contributes to a more positive classroom experience (question (4), addressing RQ2) but less helpful (question (2), addressing RQ1), especially in other non-robotics engineering courses. The students also feel the undergraduate IAs helped them feel more included or comfortable participating in class activities (slightly agree, question (6), addressing RQ2).

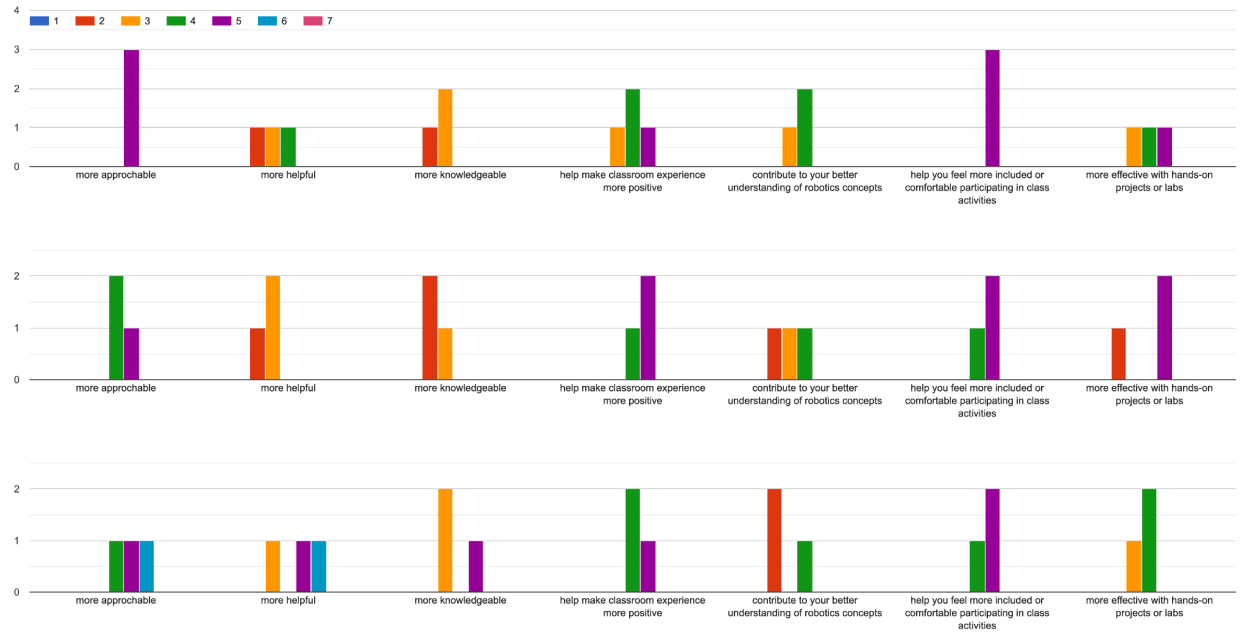

Figure 7: Self-rated Likert scale response serving as undergraduate IAs for other courses. The sub-questions include (1) more approachable, (2) more helpful (3) more knowledgeable (4) help make classroom experience more positive (5) contribute to your better understanding of robotics concepts (6) help you feel more included or comfortable participating in class activities (7) more

effective with hands-on projects or labs. Top row: for other robotics courses. Middle row: for non-robotics engineering courses. Bottom row: for non-engineering courses. Same color bar and Likert scale legend as previous figures.

QUALITATIVE RESULTS

This exploratory study also provided opportunities for qualitative responses in six themes, from the perspective of a serving/served IA: undergraduate IA roles and experience, training and preparation, interaction and impact, professional development, challenges and support, and team dynamics and recommendations. The first theme discusses what are the motivations to apply for/work as an IA and their perceived major responsibilities as an IA. The second theme describes the training or resources received when serving as an IA. The third theme echoes the self-rating of teaching style in the quantitative results (self-rating section), and asks about the self-rated teaching and interaction style and what makes IAs effective. The fourth theme discusses skills gained and how serving as an IA shaped career interests or aspirations (addressing RQ3). The fifth theme discussed the challenges the IAs faced and any mentorship and support could have been helpful. The sixth theme discussed collaborating with other staff members and overall suggestions and recommendations.

Table 4 shows a list of the thematic analysis results for the qualitative responses. The first column reflects the six themes described above. Within each theme, we labeled sub-themes, and provided the example qualitative responses. In the following, we will discuss each theme and share some interesting observations and takeaways. Note all responses in this section are expressed from a working IA's perspective, from those who have served or currently serving in an IA role.

Theme 1: Role and Experience

We extracted two branches from this theme, The first branch, with sub-themes enjoyment, curiosity and interest, improvement including self- and course-improvements, and outreach, discusses the motivation of why they worked in the IA role. Some key observations from the responses include enjoyment of the course (being a student in the course before), interest in taking on a teaching role, and to improve the course content as well as to achieve some self-improvement. The second branch, with sub-themes lab/project help, course content help, and grading help, discusses the actual roles and responsibilities the IAs shouldered. There are an even distribution between the three major responsibilities in helping with labs and projects (including debugging and maintaining hardware), improving and helping creating/testing course content, and helping with grading. Grouped under course content, one response also highlighted the communication aspect of helping with course content (how to improve the *explainability* of the content?)

Theme 2: Training and Preparation

In this theme, the responses express the types of training and preparation for the IA role, as well as their suggestions, if any, about additional resources and support. Currently, from the responses, IAs go through the required training which contains a university training course as well as a practice teaching session. All responses highlighted the ability and appreciation of "learning on the job", and leveraging course resources specific to each course (e.g., communication methods such as Slack, and/or reaching out to existing senior staff of the instructional team) to improve the IA skills and knowledge.

Theme 3: Interaction and Impact

This theme asks the IAs to self-describe their interactions with students (e.g., approachable, collaborative, authoritative, etc.) and discusses the factors that would make undergraduate IAs particularly effective in supporting student learning. The major theme is "approachable" – All IA responses self-rated their style as approachable, some collaborative in addition. Key words in the responses include "feel more comfortable/very comfortable" (2 out of 3 responses), "relaxed and relatable", "friendly", which addressed RQ1 (yes, the self-rated IA style is approachable) and RQ2 (yes, IAs improved a sense of comfort/ease/friendliness in the classroom). Two out of three responses spoke about the friendliness in having a peer instructional assistant, such as "I think that IAs work really well in that they are someone who is close to your age, went through the class, and knows firsthand what things you might be struggling with and how you might be interpreting the material. Oftentimes I would reassure the students about their struggles and validate them, and work with them to try and point them in the right direction, helping them see what the correct solution was and showing them how we can arrive at this solution". The response also highlights that the IAs "know people in the course who are very comfortable coming to you for help" and "it helps get conversations started and allows you to be a bigger help than when students are scared to ask questions." It is interesting and rather profound to see the IAs' self-reflection and discussions on the IA role, where they evaluate and see themselves not only as a "technical helper", but also creating a sense of comfort and alleviating the "scare" for peer learners in the classroom.

Theme 4: Professional Development

This theme asks how has the IA experience shaped career interests or aspirations within STEM fields and any new skills (e.g., communication, leadership, technical) gained through IA role. This is closely related to RQ3. The responses focus on improved leadership and communication skills as well as enhanced technical abilities, where responses such as "learned a lot" "much better communicator". All three responses stated the IA experience has "assured" (raising confidence) and shaped their interest in teaching. All responses also expressed a sense of positive attitude and joy, using expressions such as "reassured myself", "enjoyed"(appeared three times), "positive impact", "always loved", "really made me enjoy teaching...which I never really expected". Based on the qualitative responses, we observe the IA experience strengthened a

sense of confidence in teaching and engaged and inspired thoughts on "in the future become a professor/GSI", as an example.

Theme 5: Challenges and Support

This theme discusses challenges and support faced by the IAs. The key subtheme is technical challenges and gaps. Usually, IAs have taken the same or relevant course, so they should be well-acquainted with the course content from the student perspective. However, as the response examples state, sometimes they realize that there are a lot of materials or "backend" information that goes in that may be required for IAs to know in order to better understand the robot system and better assist the new group of students in class. Such technical gaps have been mentioned frequently in the responses. To address this, more senior staff (either a graduate student instructor, or a more senior IA with more experience, or the faculty members) may serve as an additional resource in case there is a gap in knowledge. On the other hand, it is shown in their responses that an appropriate amount of directions and guidance is suggested to facilitate clear communications within the instructional team.

Theme 6: Team Dynamics and Recommendations

This theme asks the IAs' self-evaluation of how well they collaborated with other staff members, and any general recommendations. "Collaboration" is the keyword that appeared in every response, and all responses rated themselves as forming a good collaboration and relationship with the instructional team. "Communication" is another keyword that has repeatedly appeared in the suggestion, encompassing communication with the instructional team on expectations, roles, and technical details, and also technical proficiency in making sure the communication channels are smooth (e.g., make sure notification is turned on).

Table 4: Thematic analysis results, including five themes, sub themes and example responses for the self-reported IA experience.

Theme	Sub themes	Example responses
Role and experience	Enjoyment	● "I enjoyed taking the course…" ● "I really enjoyed being a student in [the course], and so I knew I wanted to give back by being an IA for the course. I also just have always enjoyed teaching…"
	Curiosity and Interest	● "Most of my motivation was out of curiosity for what the experience would be like" ● "after thinking about it I was very interested and decided to apply"
	Improvement	● Course improvement: "I felt like [the course] could be

		improved and I could provide valuable input." ● Self-improvement: "...wanted to gain more experience by being an IA to help me prepare for a world where I eventually go to grad school and become a GSI with more responsibilities."
	Outreach	● "the professor for the course that I was teaching reached out to me before the semester began and asked if I wanted to"
	Lab/project help	● "My major responsibilities involved running lab sections and office hours" ● "My major responsibilities were to plan the labs that I was tasked with leading, leading those labs, as well as running office hours and helping with grading."
	Course content help	● "My primary responsibilities as an IA for [*Course1*] were to know my course material and how to explain it, debugging the robots… " ● "Knowing the course material sounds easy enough, as it is an intro course, however knowing how to explain it to people who have no coding background is harder then it sounds. To be able to properly explain these concepts requires you to know how they work to some degree and to be able to view things from the student's perspective as someone who doesn't know anything potentially." ● "My major responsibilities involved …as well as doing course development for the labs."
	Grading help	● "We also had to do some work for creating and grading the exams, and we did some other grading things also." ● "My major responsibilities were to … helping with grading."
Training and Preparation	General Requirement	● "I took that required orientation course." ● "the rules and regulations from the university. We also get one practice lesson that we have to give in front of other IAs and GSis." ● "I received the canvas training course as well as the one practice teaching session and that was all."
	Course-Specific Resources	● "I mostly learned on the job and was working with other people who knew what they were doing and took from their example which I thought was helpful." ● "I feel like depending on the class having someone experienced run it with you the first couple lab sections really helps to understand what is expected of you and what questions may be asked so you can be prepared to answer them." ● "I do think that our course specific resources were wonderful

		to utilize." ● "Having our course slack [communication channel] where if there were any issues I could easily contact [the professor, graduate student instructor or other IA] and have some fix or solution was essential for my success as an IA." ● "getting more time to get acquainted with the course would have been good."
Interaction and Impact	Approachable	● "In my interactions with students I try to be approachable so they feel more comfortable to ask questions to me. To me this is the most important thing to do to support student learning." ● "I think that my interactions with students was very approachable and collaborative." ● "I think that my interactions with students was good and friendly."
Professional development	Interest in teaching	● "It definitely shaped my interest in teaching," ● "Honestly being an IA helped me reassure myself that I really enjoy teaching and helping students learn material." ● "My experience has really made me enjoy the teaching aspect and helping people learn which I never really expected."
	Communication skills	● "I feel that mostly my communication and presentation skills have improved a lot, and also answering questions on the fly, which are all things I use to struggle with a lot more." ● "I've learned a lot about how to convey information and what sort of techniques are effective at helping people understand new content." ● "I think that I learned a lot about … communication and saw how I could improve in those areas. I know where I could have been a much better communicator and could have been more available."
	Leadership and Impact	● "I always loved helping people out or giving advice and have positive impacts on others, and being an IA has really been able to let me do that." ● "I do think that should I in the future become a professor/GSI, I will really enjoy teaching as part of my job/study." ● "I think that I learned a lot about leadership"
Challenges and support	Technical knowledge	● "When I first started out the thing I struggled with the most is providing help to students for the technical labs where I didn't know how the technology even worked myself… I was familiar with how to do it as a student, but not sure how it operated on a more deeper level to be able to properly debug labs to support students." ● "Honestly the biggest challenges I faced were the gaps in my knowledge…I am not that great when it comes to hardware issues and fixing them."

	Direction and Guidance	• "I think just getting used to it. I was so new to being an IA that it was very hard to know what to do and when I was supposed to act, especially at the beginning." • "I feel like thanks to my partner than ran the lab sections with me I felt like I had enough support, but without them I definitely would struggle a lot more and would be more scared to not know anything." • "Often, I would just give these issues to [graduate student instructor or other more experienced IA] because they know a lot more about how to fix them and that would usually work." • "I think faculty did provide mentorship and support and I learned a lot, but a bit more direction at the very beginning would have been good. Even if it was just this is a task you are expected to do since I never wanted to overstep."
Team dynamics and recommendations	Collaboration	• "I'm able to collaborate with the staff well, I feel like I've made good relationships with the other IAs, GSIs, and professors that I've worked with throughout my semesters as an IA in [*Course2*] since we had a small instructional staff I feel like this is definitely true." • "We all collaborated really well honestly." • "I think that I collaborated very well with the other IAs and the professor for the course."

DISCUSSION AND LIMITATIONS

As described above, we present an exploratory set of data and results from quantitative and qualitative responses from previous staff who have undergraduate IA experience. To address RQ1, based on the quantitative data as rated from a student perspective, the students do in general find undergraduate IAs more approachable, but less helpful than graduate student aides in hands-on settings. The IAs were helpful in curriculum development, but less knowledgeable than the senior members (e.g., graduate student instructor, faculty, or senior/returning IAs) in the instructional teams. To address RQ2, the students in general rated IAs are easier to relate to, but seem neutral in the classroom environment. Note that when responding from the perspective of the IAs, all responses actually rated positively in terms of having a positive impact in the classroom environment. To address RQ3, the responses indicate that all IAs experienced enhanced confidence and interest in academic teaching (some even to their surprise), and many indicated that the experience improved communication and leadership skills which may be useful for future careers in STEM.

Comparing the two course contexts, qualitative responses that mention *Course1* emphasized robot hardware issues and debugging, which was expected based on course content. The small

staff size was mentioned for *Course2* as being a positive factor in promoting a good relationship between the IAs, GSIs, and faculty in the instructional team.

There are some discussions and reflections on the limitations given existing results. First, we acknowledge that this is only as an exploratory study and the responses may be dependent on the individualized IA experience. Given the extremely small sample size (n = 3), reliability estimates and inferential statistics are unstable and are reported solely for exploratory transparency. We computed the Kruskal-Wallis U test on the Likert scale scores, however, due to the limited sample size, the test result found non-significant difference with p=0.248 when computing the median rank score amongst the four groups (*Course1* and *Course2*, Other robotics courses, other non-robotics engineering courses, and non-engineering courses). If resources allow, future research can be conducted for a larger pool of students with and without IA experience, and more comprehensive statistical tests can be tested. Second, this study only looks at the past two academic offerings as context. Response data may be obtained after multiple-year offerings and can be used to analyze whether a recurring IA have similar or different perspectives and levels of "approchability and helpfulness" (although current qualitative data did mention more senior IAs were more helpful within an instructional team). Third, with respect to the IA's professional development, if possible, longitudinal data on the IA's future study and career trajectories may be of interest to explore further, such as whether there is a correlation between eventual academic research and teaching career and the IA experience as an undergraduate. Fourth, there were some discussions in qualitative response about staff size, that when the instructional team has a relatively staff size the IAs felt a closer connection and better communication, compared with a larger team. This would be dependent on other factors such as IA and graduate student availability, class size, budget, etc. Yet, there may be a balance point where the instructional team is well staffed so that the students in the classroom can feel fully supported and the IAs can fill in each other's technical knowledge gap if any, yet the instructional team isn't so large that there would be miscommunication within staff members. Finally, this study can be expanded to other courses and it would be interesting to compare across robotics-specific curriculum, and across multiple disciplines within engineering.

CONCLUSION

This paper presents quantitative and qualitative results for an exploratory study on the role and impact of undergraduate instructional assistants (IAs). Through detailed Likert-scale-based responses and qualitative expressions, we observed positive aspects of the IA experience such as increased teaching interest and confidence, more approachable for peer learners, and enhanced communication and technical skills. We also recognize potential suggestions such as mixing senior-level instructional staff and IAs with less experience to fill in the knowledge gap, and communicating clearly as a faculty member to ensure the expectations and IA roles were set effectively, and to support the professional development of the undergraduate IAs.

REFERENCES

[1] Mena, I. B., & Diefes-Dux, H. A., & Capobianco, B., "*Doctoral Students as Course Instructors: Three Engineering Teaching Assistants' Socialization Experiences*," ASEE Annual Conference & Exposition, Vancouver, BC, 2011.

[2] Brannon, M. L., "*Using Peer Teaching Observations to Give Feedback to Graduate Teaching Instructors*", ASEE Annual Conference & Exposition, San Antonio, Texas, 2012.

[3] Guadagni, G., & Ma, H., & Wheeler, L. (2018, June), The Benefit of Training Undergraduate Teaching Assistants Paper presented at 2018 ASEE Annual Conference & Exposition , Salt Lake City, Utah. 10.18260/1-2--31079

[4] Robinson, C., & Collofello, J. (2012, June), Utilizing Undergraduate Teaching Assistants in Active Learning Environments Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--22212

[5]Dai, Y., & Li, T., & Liu, A., & Lu, S. (2018, June), P2P Platform for Peer Instruction in Flipped Classroom Paper presented at 2018 ASEE Annual Conference & Exposition , Salt Lake City, Utah. 10.18260/1-2--30854

[6] Gopal, B. (2024, June), Teaching SOLID Software Design Principles Using Peer Instruction—A Pilot Study Paper presented at 2024 ASEE Annual Conference & Exposition, Portland, Oregon. 10.18260/1-2--48068

[7] Clinkenbeard, D. A., & Gross, J. B. (2023, June), Plickers and Peer Instruction in a Software Design Course Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore , Maryland. 10.18260/1-2--43901

APPENDIX

COURSE SUMMARY AND COMPARISON

We provide some additional context about Course1 and Course2 below. These two courses were selected as study context as both courses are part of the undergraduate robotics curriculum with an emphasis on project-based learning and working with real-world robotic platforms. Table 1 provides a summary of the course contexts. From an undergraduate instructional staff point of view, there are some similarities and differences between the courses. For similarities, both courses are robotics courses and involve real robots. Both class sizes are roughly on a similar

scale (around 25-30 persons). In both classes, undergraduate IAs typically work in a group setting (there are multiple IAs as well as faculty and/or graduate staff present). Undergraduate IAs help out with lab and project time and interact with the students in class during lab time and in office hours.

For differences, first, *Course2* focuses more on the interaction between human and robots and, thus, works with multiple robotic platforms, while Course1 only has one wheeled robot platform throughout the semester. *Course1* robot platform is portable, meaning the students typically can carry with them or be stored and individually obtained through a locker system. *Course2* robotic platforms are typically set up by the instructional team before class due to the complexity and multi-part system setup. Due to this, IAs in *Course2* are typically expected to help more with the hardware set-up, charging the batteries, checking all systems work, etc., while *Course1* staff typically dedicate more time to the coding and debugging aspects of the projects. Second, even though both courses work with robotic projects, *Course1* projects are typically completed on an individual basis, whereas *Course2* projects are typically completed on a group basis (in most cases, the human robot interaction scenario needs multiple humans present to be the participant and observer, such as to investigate a group dynamics scenario). Thus, *Course1* staff typically interacts with individual or pairs of students (pair programming, if the students so choose), while *Course1* staff typically interacts with groups of students (typically, groups of 3-4). Third, during office hours, *Course1* staff (faculty, graduate and undergraduate staff) typically receive more questions and requests on the technical aspects, such as “how to code this”, “why is there a runtime error”, and so on. *Course2* staff typically use the office hours for helping with late assignments (e.g., make-up labs), as the student(s) may need one or multiple IAs to complete the group interaction scenario to complete the lab assignment. Finally, while IAs help with grading in both classes, *Course1* has more frequent, low-stake quizzes (five quizzes total throughout the semester on coding and algorithmic concepts), whereas *Course2* has more technical writing and reflection question submissions. One example from the *Course1* quiz could be, “please write C++ code for iterating from 1 to 100.” Another example from *Course2* lab assignment could be, “what emotion do you observe from the human-robot interaction scenario and why?” As shown, *Course1* quiz questions typically have a “correct” answer, although it is possible to have multiple solutions. For the above simple example, the student can choose to do a for-loop or a while-loop or write in many different ways, but the output is concrete and fixed - printing out the numbers 1 through 100. On the other hand, while *Course2* does have some assignment and exam questions that are deterministic (having one fixed “correct” answer, such as multiple choice-type questions), a significant portion of the lab assignment for *Course2* is on open-ended reflection. Grading rubrics are based on the thoughtfulness and originality of the answer, the relevancy to lecture content and literature, the application of quantitative and qualitative tools discussed in the course, and insightful and reasoned reflections. Thus, the faculty typically leads the grading and the undergraduate IAs help by providing comments and feedback, or highlighting outstanding responses.

Table 1: Summary of the similarities and differences between *Course1* and *Course2* in terms of course content and undergraduate instructional assistant roles and responsibilities.

		Course1	*Course2*
Course Content	Working with real robot	✔	✔
	Software debugging	MORE	LESS
	Hardware setup	LESS	MORE
	Team project	✔ (group size 1-2)	✔ (group size 3-4)
	Graded quiz/exam	✔	✔
	Open-ended reflection questions	LESS to NONE	MORE
Undergraduate IA Role	Office Hours (including answering questions on Q&A platforms such as Piazza)	✔	✔
	Grading	✔	✔
	running lab/discussion sections	LESS	MORE
	Contributing questions to homework and/or quiz/exam	MODERATE	MODERATE
	Attending teaching staff meetings	✔	✔

CRONBACH'S ALPHA RESULTS

Table 2 shows Cronbach's alpha for the quantitative questions across the five aspects of undergraduate IA experience (rated as a student). The main paper "QUANTITATIVE RESULTS As a student" section has provided discussions of Cronbach's alpha with the Likert scale results. Table 3 shows Cronbach's alpha for the quantitative questions across the five aspects of undergraduate IA experience for other non-robotics courses, when rated as a student. As shown, for the construct "knowledgeability", all three contexts receive a high alpha score, indicating the sub-questions (3)(5)(7) have a high consistency and correlates to "knowledgeability". There is a relatively lower level of approachability and helpfulness score, indicating the questions "more

approachable?" and "more helpful?" may not be measuring the same thing, which makes sense, as a person was easy to approach does not necessarily mean that they were helpful.

Table 2: Cronbach's alpha for the quantitative questions across the five aspects of undergraduate IA experience (rated as a student).

Topic Area	**Cronbach's Alpha (α) Results**
Approachability and Helpfulness	-0.75
Peer connection and Comfort	0.50
Academic Support	1.00
Mentorship and Guidance	0.83
Impact and Recommendations	0.75

Table 3: Cronbach's alpha for the quantitative questions across the five aspects of undergraduate IA experience for other non-robotics courses (rated as a student).

Topic Area	**Other Course Context**	**Cronbach's Alpha (α) Results**
Knowledgeable	other ROB courses	0.92
	non-ROB engineering courses	0.80
	non-engineering courses	0.86
Approachability or Helpfulness	other ROB courses	0.67
	non-ROB engineering courses	0.57
	non-engineering courses	0.74