

More than Marking: Experiences as Undergraduate Design Teaching Assistants

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Abstract – Incorporating aspects of vertical integration into project based learning through the use of undergraduate design teaching assistants is a complicated approach in engineering education. From a student's perspective, this paper will address topics of student assessment, qualifications and expectations, issues associated with rubrics, evaluation of fellow students, design subjectivity, and overall recommendations. This experience is valuable to engineering educators as it not only highlights the development of students with undergraduate teaching assistants, but also the development of the teaching assistants themselves. This paper examines the benefits, challenges, and considerations experienced in engineering design courses with undergraduate TA's from the perspective of an undergraduate student – first as a student, and then from a teaching role as a teaching assistant.

Keywords: Undergraduate; Teaching Assistant; Project Based Learning; Design; Vertical Integration

1. INTRODUCTION

The implementation of undergraduate teaching assistants (TA's) in design-based engineering courses has been increasing with the addition of more design focused courses being incorporated into the engineering curriculum, as they are more accessible and cost effective for a professor to hire compared to graduate students, and may be necessary for universities without a graduate engineering program. The use of undergraduate design TA's has also become more prevalent as research into vertical integration has shown promise and value in enriching undergraduate engineering education [1].

Aside from general course improvements in terms of the tasks of grading and identifying which students may need help, this also serves as a tremendous opportunity for learning and development of the undergraduate TA. The TA will have the opportunity to develop their

communication and organizational skills, all while gaining an appreciation for working in an academic setting.

Traditionally, teaching assistant positions are filled by graduate students in which appropriate training programs and workshops are used to educate and prepare individuals for the task of being a TA [2]. As undergraduate students have not historically been hired as TA's – especially in engineering design courses – this resource is generally not available. This point, alongside the potential deficit in engineering design experience may dissuade professors from hiring undergraduate students as design TA's. This not only takes away the opportunity for the undergraduate student to gain valuable experience and knowledge in an academic setting, but can limit students in their courses from the educational benefits associated with having an undergraduate TA in terms of vertical integration, recent relevant experience, and a fresh perspective. Although the undergraduate TA may lack the expertise, teaching experience, and pedagogical knowledge, they often times do not lack the motivation, and with proper guidance and outlined responsibilities, implementing undergraduate design TA's can be a great opportunity for improvement and growth for the TA, students, and professor [3][4]. In this context, TA's are truly assistants to the professor, and not expected to provide instruction or be in the class on their own, but rather assist during experiential activities in large classes, identify groups that need individual attention from the professor, and ensure students understand the activity.

Exposing students to more mature and experienced undergraduate students (TA) in a classroom or lab promotes a more diverse, collaborative, and inclusive learning environment for undergraduate students which encourages further learning, collaboration, and communication – all invaluable experiences for engineering students [5]. This application of vertical integration can naturally be accomplished directly through implementing undergraduate design TA's, allowing for improved student learning and a more complete design experience [6]. Complexities of this approach arise through effectively utilizing the TA with their given competencies, and managing the interaction between the students and the TA, and the professor and the TA.

This paper will discuss the initial experiences as a student with undergraduate design TA's, interactions a TA should have with students and the teaching professor, the learning opportunities available for a student working as a TA, and TA identified improvement areas for an effective teaching and learning environment.

1.1 BACKGROUND

This paper is presented from the perspective of undergraduate student teaching assistants from the University of Prince Edward Island, selected and hired to serve as a TA for first year engineering design courses. The position of "teaching assistant" encompasses responsibilities including: grading and providing feedback on assignments and reports, and assisting in the classroom, assembly shop, and computer lab. This position differs from the position of "student marker" which strictly entails marking assignments and tutorials with no interaction with students during lecture hours – commonly hired for more traditional engineering courses.

The ability to effectively grade and provide high-quality engineering design feedback requires extensive experience studying engineering design in an academic setting supplemented with industrial engineering design experience. As an undergraduate engineering student may lack experience in both of these areas in order to be effective, the content delivered for grading is examined more on process than product basis. On average TA's are tasked with marking content based on professional appearance, documentation, formatting, completeness, and evidence of the outlined design process. By implementing this criteria, an undergraduate engineering design TA is able to be an effective and useable addition to course delivery.

2. STUDENT (TA) LEARNING

There are many benefits to students in terms of academics, experience, and professionalism through working as an undergraduate design TA. The TA is able to observe and develop a greater understanding of how a professor works and functions in an academic setting while also obtaining an improved perspective of how and why work is assigned and grades are distributed. The experience of working in an academic setting while being exposed to the stresses and demand on professors and faculty is also highlighted through working as a TA, as well as the exposure to other undergraduate student work in order to develop a sense of expectation in terms of quality of work. This process also relates to the development of a student who is capable in design as being a TA is analogous to being a client, as there are set expectations from students being graded to produce a

certain quality of work with a standard of professionalism. Although the TA may not have any crucial industry experience to facilitate the design process, they have an improved understanding of the client-engineer relationship to benefit themselves in future years and as an eventual engineer.

Being a TA also allows students to value feedback and constructive comments from peers and professors more effectively as they are experienced with giving feedback and the rationale behind it; through providing feedback and grading themselves. The TA's skills in the area of technical writing can also be improved through critically examining a large number of reports and documents – gaining a greater appreciation and awareness for formatting, condensing content, and communication through writing. This is also exemplified in other more technical areas of student development as the TA's become more attentive to rubric criteria in courses they take with a more developed understanding of how marks can be earned and how much effort should be allotted based on a specific course's rubric and grading. A summary of some TA learning areas can be found in Table 1.

Being greatly involved within the course also allows the TA to essentially retake the course and relearn more valuable information that may have been missed or not learned with enough detail or emphasis when the TA first took the course – furthering the development of the TA as a student. This demonstrates the mindset of continuous and life-long learning (CEAB GRA 12) as the TA is forced to relearn material and even learn more material if the course covers a different variety of topics compared to when the TA originally took the course. The TA may also have the opportunity to approach course content from a much different perspective if TA employment occurs under a different professor.

Table 1: Summary of TA learning areas.

Learning Areas for TA:
- Experience working in an academic setting.
- Developed understanding of how professors work and function.
- Improved understanding of how grades are assigned .
- Greater sense of required quality of work due to the increased exposure to other student's work.
- Understanding of client-engineer relationship.
- More value is placed on feedback and constructive comments from professors and peers.
- Attentiveness with rubric use in future courses.
- Technical writing and documentation.

3. TA INTERACTIONS

A design TA is required to interact more frequently and closely with both students and professors – especially in settings outside the classroom, and with a much larger responsibility than a student marker in academic settings. These interactions function to define the role of the TA from both the student's and professor's perspective.

3.1 TA – PROFESSOR INTERACTIONS

The relationship between an undergraduate design TA and the professor is mutually beneficial and can be an asset in a teaching environment if implemented properly. If expectations of the TA are clear and established from the beginning, the experience can significantly decrease the list of responsibilities of the professor as well as provide a rewarding experience for the TA and students in the course.

It can be argued that an undergraduate student is not experienced enough in the field of engineering to be marking other students. However, the TA will be marking the design process not the final product. The TA does all the seemingly tedious marking which consists of analysis, documentation, and other types of communication completed by the students. The undergraduate TA will be more than qualified to handle this scope of work, as they will have just completed (and excelled in) the course themselves and have gained a competency and understanding in these areas. In more difficult cases that can arise in grading, the professor will take over the marking responsibilities as the TA will strictly mark according to the rubric. Furthermore, in order for this relationship to work out for both parties, it is important to have a certain level of trust.

The perspective of the TA will be more recently established than that of a graduate student, which enables valuable feedback to be provided to students as it relates to the course – with relevant insight. This can be helpful when the professor is conflicted about course material and expectations from students. If requested, the TA can provide feedback on how the content will be received or if the students will be challenged enough. Alternatively, if the students are struggling the TA could provide insight on why they believe this is happening and work with the professor to help remediate the problem.

3.2 TA – STUDENT INTERACTIONS

The initial experience a student may have being marked by another student often occurs in first year, as undergraduate engineering students are frequently utilized as TA's for first year engineering design courses. As most

first year students are enrolled into university studies directly after graduating from secondary school, there is naturally a discomfort and question of trust and qualifications upon learning that an undergraduate student – much like themselves – are responsible for their grades and academic future for a course.

From the experience of the authors, this initial experience was initially quite uncomfortable as the competency of the TA was in question. After the realization that grades were assigned based on areas such as process and documentation, these concerns were settled.

Benefits of having undergraduate TA's were then experienced as the TA's were often more accessible than professors as they also worked on course work in similar locations at extended hours – unlike set professor office hours. This provided for a more inclusive experience as feedback and recommendations on assignments were able to be received more readily. Furthermore, undergraduate TA's were viewed as more approachable compared to professors by first year students as they can be seen as peers and therefore approachable and relatable. The relationship that exists between an undergraduate TA and a student is slightly more complicated due to age, respect, experience, and familiarity. Although there is a level of seniority for the TA, ultimately there is sometimes only a one-year age difference and in some cases, the TA can be younger than some of the students. This can cause conflict as undergraduate TA does not always receive the same level of respect as a graduate TA would. This is also complicated by the fact that the students may be friends of the TA.

Engineering design courses tend to not have solution keys due to the subjectivity and uniqueness of the projects and assignments and designs are written with content that have more meaning to the students than other course subjects, design can often be seen as a very personal subject. This may be difficult for the TA as assigning marks to students based on documentation and process may be seen from the student as marks associated with their design or ideas. With the TA understanding the role of the student so well, they may be hesitant to criticize the students in fear of discouraging them. However, a balance can be found within all of these factors. An undergraduate TA can be seen as more relatable to the students. It is encouraging to see the progress and knowledge of the TA from the perspective of a student as it shows the students what they can achieve if they work hard and in which ways they can improve as an engineering student. In addition to this, the relationship between the student and TA is more casual. This does not have to be viewed as a hindrance, as this allows for more honest communication. Students can find it intimidating to ask a professor or even a graduate student TA a question in fear of looking

unintelligent or juvenile. This is especially prevalent in first year when students are not sure of themselves.

The role of the undergraduate TA can be seen as a more approachable mentor. The TA will be able to understand the position that the student is in and provide good advice while also delivering it in an appropriate fashion based on the student's skill level. Although the student and TA can relate on a different basis compared to a professor or graduate TA, there may also be conflict when it comes to students not trusting the opinion of the TA. This problem will have to be addressed early on by the professor in order to ensure that the required level of respect is given to the TA. Students will also know that the professor is always available to discuss marks or feedback given to students by TA's.

4. TA IDENTIFIED IMPROVEMENTS

Through experience as an undergraduate engineering design TA, improvements for creating a more productive placement with improved benefits to students, TA's, and professors are identified in the areas of: Selection process, expectations, continued communication, and grading consistency. A summary of potential improvements from the perspective of a TA can be found in Table 2.

Table 2: Summary of improvement areas.

Area	Improvements
Selection Process:	<ul style="list-style-type: none"> - Interview process asking questions about student's strengths, course load, work ethic, organization, and communication. - TA cohesiveness.
Expectations:	<ul style="list-style-type: none"> - Clearly communicate and outline expectations and responsibilities. - Determine how TA is to be used for marking and/or for CAD or assembly shop supervision only.
Continued Communication:	<ul style="list-style-type: none"> - Consistency with lateness policies and communication if there are exceptions. - Updates on classroom activities and what students are being told regarding assignments, projects, and deadlines.

Grading Consistency:	<ul style="list-style-type: none"> - Averaged marks if multiple TA's are used to eliminate biases. - Clear and understandable rubrics.
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4.1 SELECTION PROCESS

The selection of a TA is very important and should not be based solely on GPA. Although the grade the TA received in the course they are applying to mark for is important, it should not be the only factor in consideration. An interviewing process should be conducted where the student is asked about their strengths, which will be important in assigning marking tasks later on, their semester's course load, and their developed skills in the areas crucial to design such as documentation and engineering design process. As engineering design courses require weekly or twice weekly assignment submissions, and assignments build upon previously submitted assignments, it is crucial that the TA is organized and able to complete marking and providing feedback promptly. This is very important for the above reason and also due to the deadline-driven nature of design courses, especially those with industrial or community partners involved. Communication skills and personability should also be considered during the selection process as a TA will be required to interact effectively with students in the course in the classroom, lab, and also through email or online correspondence on several occasions.

4.2 EXPECTATIONS

Once the TAs have been selected and hired, it is important to clearly communicate what is expected from them in terms of the needs of the professor, the needs of the students, and the responsibilities the TA will have. The strengths of the TA will have been determined in the interview, and the TA should be assigned to mark a component of the course that they are confident and experienced in. For example, if the TA feels their strength is in technical writing, they should be assigned to mark documents to provide the fairest assigning of marks and most valuable feedback to the students. In addition to this, clear guidelines must be provided. There should be clear rubrics provided to the TAs, and discussion of these should be required at the beginning of the semester and regularly throughout the semester. This ensures that the TA understands what they should be looking for while marking. Rules such as deductions for late assignments must be consistent and clear. Otherwise, there will be a lot of confusion and unnecessary conflict between the

student, TA, and professor. The expectations regarding the breakdown of marks and how these marks should be presented to the professor is also crucial. A contract of sorts outlining all of these rules could be provided at the beginning of the semester to be used as a reference and to clear up any confusion.

4.3 CONTINUED COMMUNICATION

Communication between the TA and professor will have to be consistent throughout the span of the semester. Several different issues will occur that will not have been covered in the aforementioned contract, and these will have to be dealt with on a case by case basis. At this point, the professor will have to determine if they would like to deal with these issues or leave it up to the discretion of the TA which should be made explicitly clear – such as deduction of marks for lateness, applying curves, or adjusting averages.

Ideally, the TA should be sitting in on important lectures in the course in order to gain a clear understanding of what the students are being taught and instructed to do for projects and assignments. This will ensure that the TA is properly informed and aware of the status of projects and deadlines. Although it would be ideal for the TA to always be present in class, due to conflicting schedules it is more common that the TA is not present for all lecture and contact hours. In this case, the TA will need to receive updates on what is going on in class and what the students are being told in order to mark the students appropriately. For example, if the professor decides in class that a certain part of a document is not needed for a submission, this must be communicated to the TA before marking commences. This kind of disconnect, when avoided, can lead for a more efficient functioning of a course.

4.4 GRADING CONSISTENCY

If multiple TA's are utilized in a design course, an effort must be made to ensure fairness to the students in the course in terms of marking and consistency in feedback. This is of main concern to the students in the course in order to establish a consistent grading practice and standard course experience. By having multiple TA's marking the same assignments or projects, grades can be kept consistent and any biased opinions will be avoided. A final mark can then be averaged from all the TA's marks with a compilation of feedback to then be given to the student. This ensures that the deliverable is marked fairly and the student also receives feedback on multiple improvement points – furthering the development of the student.

5. CONCLUSION

The implementation of undergraduate students as TA's for design courses has been discussed as a method for enriching student and TA learning in an academic setting while providing benefits not necessarily present utilizing graduate student TA's. Through acknowledging the experience and academic background of undergraduate students to perform task as a teaching assistant, an undergraduate student can be effectively utilized as a TA to allow for the educational benefits associated with vertical integration while also serving as a valuable learning experience for the TA as a student. The use of an undergraduate design TA is a mutually beneficial relationship as the TA can support the professor when graduate students are not available, enabling the professor to be able to focus their time with students that need the most attention during active learning exercises while providing help with marking and activity coordination. This experience allows the professor to receive the help they require, all while the TA learns valuable skills such as attention to detail, technical writing and documentation proficiency, and communication – all while gaining experience working in an academic setting.

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