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Work in Progress: Development and Facilitation of a New Certificate/Class for Undergraduate Teaching Assistants in Engineering and Computing Programs

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Work in Progress: Development and facilitation of a new certificate/class for undergraduate teaching assistants in engineering and computing programs.

Introduction:

In higher education, faculty often have a number of impressive responsibilities, such as providing quality research, grants and other services that can distract them from their ability to provide quality attention to their students. These responsibilities can also, unintentionally, impede their ability to focus on delivering their best and high quality and impactful classes and curriculum. Although faculty are generally very skilled at providing domain specific content for their students, oftentimes these students are unable to connect with their instructors due to lack of time or large class size. This challenge has led to misunderstandings being created leaving students to feel their faculty are unavailable during their academic career.

To provide quality engineering education, creative solutions and new practices must be investigated that will improve the quality of engineers. Faculty and the graduate teaching assistants can not alone solve this challenge. Additionally, beyond 'feeling' prepared, students need to be empowered to persist in their programs, especially in institutions with large class sizes. As a solution to the problem and to open new non-traditional pathways for students to succeed, a midsize minority serving institution in specific departments, formulated a program allowing undergraduate students to serve as teaching assistants starting in 2005.

Due to the success of this program, the model was then adopted college-wide in the College of Engineering and Information Technology (COEIT) at the University of Maryland Baltimore County (UMBC). These students, known as teaching fellows, not only have an impact on their engineering and computing peers (students who they taught), but also develop skill sets in an unconventional way giving them new routes into academics and industry. Many in their third, fourth or fifth year of their program, perform, act and behave as potential future faculty (lead their own discussion/class, grade papers, hold office hours etc). In a recent case study [1], students discussed their consideration going into faculty positions and found this program increased their efficacy in both their professional and technical competencies.

In the commitment to teaching and innovation excellence, UMBC decided to become a Center for the Integration for Research Teaching and Learning (CIRTL) member in 2016. The program is housed in graduate school and is a part of the future faculty development program. To support the movement towards creating better teaching faculty and its goals to improve STEM undergraduate education, proposed and was approved to develop a certification to the undergraduate population. Distinguishing itself from the graduate level, it was named CIRTL undergraduate associate certificate. To earn this certification the students must complete the following seminar classes:

- Engineering 396 (ENES 396): Fundamentals of Teaching Fellow Scholarship
- Engineering 397 (ENES 397): Advanced Topics of Teaching Fellow Scholarship

Both seminar classes were developed through the Engineering and Computing Education Program, held in the COEIT, allowing multidisciplinary enrollment. CIRTL curriculum and other in house pedagogy were utilized and redesigned to be digestible for undergraduate students.

In this work-in-progress paper, class discussion of teaching philosophy, mid semester 'bullet list' development and full teaching philosophy statements generated by the teaching fellows were examined for successful outcome achievement. The data collected will be used to help assess the effectiveness and further develop the seminar class.

Relevant Literature

Since the late 1990's, Undergraduate Teaching Assistants were utilized in, for example, psychology departments as an answer for deficiencies in resources and personnel. However, the responsibilities only included grading, assisting in the classroom or holding office hours [2, 3].

The Need for UTA or Teaching Fellow

Ample literature demonstrates that a peer-mentor and peer learner positively impacts an undergraduate student's learning experience. For example, Dickson discusses how in computer science courses "having undergraduates as teaching assistants helps to engage students with the material, creates a more relaxed classroom environment in which students feel more free to ask questions, improves the effectiveness of class time, and improves class quality" [4].

UTAs show to be able to keep track of course material and provide more relevant and relatable examples during their discussion [5, 6]. Aside from requiring lecture attendance, UTAs often meet with the faculty and collaborate with other peer teaching assistants. "*Using undergraduate students as teaching assistants creates a unique community that provides authentic learning in the classroom, provides deeper connection in the culture and understanding diverse learners developing improved pedagogical practices [1]"*

The need for more deeper training

Some, but limited literature has reported an undergraduate teaching assistant training. For example, At Indiana University East [5], the psychology department was facing a deficit of faculty to accommodate the number of students enrolled. To fulfill the needs of the department, undergraduates were hired as both teaching assistants and research assistants. Any student interested in applying as an undergraduate teaching assistant (UTA) was required to complete a one-credit course titled "Psychology applied to teaching" before they can begin their duties as a teaching assistant. In this program, faculty are instructed to "integrate the student into the development of the course" and provide mentorship to the students. At the end of the semester, each UTA is given a questionnaire to reflect on their experience as a teaching assistant [5].

The psychology department at the University of Scranton [2] used a similar approach in their training of UTAs in their undergraduate coursework. The students must first complete a one-credit seminar to prepare for their teaching assistantship. The training seminar consisted mostly of the students developing an assessment schedule for a sample psychology course and involved only one instance where the students were given the opportunity to learn how to teach.

This teaching opportunity involved recording a brief class presentation and then critiquing the video. The roles of a UTA in the University of Scranton's psychology department consisted mostly of more tedious and menial tasks, such as grading quizzes, taking attendance, and obtaining resources from the campus library [2].

Romm et al., at Brandeis University, discussed creating an internship course for undergraduate teaching assistants to dive deeper into science teaching and pedagogy. They found that a course like this increased the student's confidence levels "with regard to teaching and better awareness of the difficulties faced in science education"[7].

Structure of Engineering 396 & 397

To earn an Associate Undergraduate Center for the Integration for Research Teaching and Learning (CIRTL) certificate, students must be an active teaching fellow during their time in Engineering 396 (ENES 396) and must complete both seminar classes with a passing grade of P. Below describes the content that is facilitated throughout the semester.

Engineering 396 (ENES 396): Fundamentals of Teaching Fellow Scholarship
This is the first course in the two semester seminar sequence that is designed to enrich undergraduate teaching assistant knowledge and understanding of the scholarly practices of teaching, learning and research. Throughout the semester, students attend workshops and seminars that focus on the researched and applied best practices in the field of Engineering and Computing education. Further, teaching fellows are encouraged to develop a teaching philosophy. As topics are introduced, the instructors encourage students in both discussion and thoughtful development of how this applies to their own teaching practice.

ENES 396 Students engage in various fundamental workshops and seminars in Engineering and Computing Education not limited to Scholarship of teaching and learning, Cultural Awareness and Diversity, Equity and Inclusion as shown below.

Topics covered in ENES 396 include the following:

- What is Evidence Based Teaching?
- Developing and facilitating effective teaching
- Peer and Instructor Feedback
- Bring An Inclusive Mindset to Your Teaching
- Active Learning
- Ethical/Social Responsibility in the classroom
- How do we assess learning?
- Graduate Student lead Workshop - Peer Assessment
- Writing a Effective Teaching Philosophy

Engineering 397 (ENES 397): Advanced Topics of Teaching Fellow Scholarship
This course is designed to continue to elevate the undergraduate teaching assistant knowledge and understanding of the scholarly practices of teaching, learning and research. Throughout the semester, students attend workshops and seminars that focus on the researched and applied best practices in the field of Engineering and Computing education.

As more of a practitioner course, students serve as peer advisors, and will engage and facilitate in higher level learning and research in Engineering and Computing Education. These students are expected to participate in more advanced topics related to teaching, research and learning. Further they will be a peer-mentor for 396 fellows for the semester.

Topics covered in Engineering 397 included the following:

- Completing a Research project related to a topic around the Scholarship of Teaching research and learning with the intent of presenting at a conference.
- Attending two advanced workshops with Faculty at the home institution
- Peer Mentoring: Students will mentor their 396 peers and provide evaluation on their teaching practices and facilitation throughout the semester. This includes them attending one lecture/discussion of their peers.
- Team lead and facilitate one 396 discussion/lecture. Students will plan and facilitate a topic in 396 that will be approved by the instructor.

After completing ENES 397 and a research project, students will earn undergraduate CIRTL associate certification.

Course outcomes for these seminar-like classes were aligned with the mission of CIRTL to include Teaching as Research, Evidence-Based Teaching, Learning Communities, and Learning Through Diversity. These outcomes can be found in Appendix A [8].

Methodology for assessment:

In this small case study, qualitative methods were used to assess the effectiveness of the seminar. Three stages were used to gain preliminary information for future research and development.

A. First Day - Think, Pair and Share
   Instructors lead the group in a discussion around the understanding of the development and purpose of having a Teaching Philosophy. Using the think-pair-share practice, students talked about their thoughts and opinions on the purpose and practices of creating and having such a philosophy. These were shared among the class and the instructors wrote them on a whiteboard to show commonalities.
B. Midsemster bullet point list on the students teaching philosophy
   After students engaged and participated in several sessions in the scholarship of teaching and learning, the instructors assigned a mid semester opportunity for the students to reflect on how they would begin to develop their own philosophies. Frequencies, or counting, were used to assess how often a student included a topic that was recently covered in the class.
C. Full Teaching Philosophy Statement
   Final assessment included an examination of the full developed teaching philosophy statements using the pedagogical topics and approaches covered in the class as constructs. Themes and subthemes were derived and analyzed.

In each of the phases, themes were derived and examined to understand the development of the students' knowledge of the scholarship of research, teaching and learning.

Formative evaluation was given throughout the semester providing students opportunities to connect and critically think about how each topic reflects their own teaching ideology. These reflections were generated to help the students to develop their philosophies. As this is a new initiative, and to ensure proper and appropriate development, this paper only wil report on the first cohort, single section, of students who recently completed Engineering 396. Ongoing research is planned to provide extensive thorough results of this initiative.

Demographics
Below in Table 1, represents the first cohort of students in Engineering 396.

Table 1: Demographics of Enrolled Students

Variable	Value	Frequency	Percent
Gender	He/Him/His	12	57.14%
	She/Her/Hers	8	38.10%
	Non-Binary	0	0.00%
Unit	Chemical Engineering	5	23.81%
	Mechanical Engineering	4	19.05%
	Computer Engineering	1	4.76%
	Computer Science	8	38.10%
	Pre Computer Science	1	4.76%
	Information Systems	1	4.76%
	Statistics	1	4.76%
Graduate Status	2nd year	4	19.05%
	3rd year	2	9.52%
	4th year	15	71.43%
Ethnicity	Asian	6	28.57%
	Black/African American	4	19.05%
	Hispanic/Latino	1	4.76%
	Not Specified	2	9.52%
	White	8	38.10%
Total		21	100.00%

Results from the study

What is a teaching philosophy statement? (Beginning of the Semester)

On the first day of Engineering 396 class, the instructors lead the students in a discussion around the meaning and value of having a philosophy in teaching. Students were directed to follow a think-pair- share style, first in their groups and with the class. Below are common and the most agreed upon statements around what should be included in and have in a philosophy of teaching:

- Best practices, as collected from the class
- Transparency, honesty, effectiveness, and adaptive. Being humble, ethical, and engaged.
- Know your role, be hands-on, open minded, and friendly.
- Be understanding, approachable, and helpful.
- Use real world examples, demonstrate in class, and use group work.
- Be inclusive and authentic.

When asked how they formulated these principles, many of the students reflected on their experiences (whether negative or positive) as being a student or current teaching fellow.

Bullet point Teaching Philosophy: ***(Mid Semester Check)***

To assess learning and promote thoughtful reflection, the instructors asked the students to create a preliminary simple form of their philosophies around teaching and learning. This assignment encouraged them to create an elementary bullet list of ideas or notions. At this point, topics covered in the class included Evidence based teaching, Developing and Facilitating effecting teaching, Peer and Instructor Feedback, and Bringing an Inclusive mindset.

Below shows the frequency each of these topics mentioned, either implicitly or explicitly in their bullet list:

Table 2: Bullet list for Teaching Philosophy

Topic	Frequency	Example Quote from students
Evidence Based Teaching	62%	“Active learning is the most effective learning technique, especially with real life or applicable problems” “Put an emphasis on prerequisite knowledge to reinforce students' previous learning and help build confidence for the rest of the course.” “Help cement the building blocks that will help students new to coding strengthen their critical thinking skills as they relate to programming / communicating with technology through code”
Developing and Facilitating	62%	“Out-of-the-box thinking leads to new ideas, therefore

effective teaching		its important to foster creative problem-solving and curiosity emphasizing equity amongst students in order "to ensure that all students get the same quality of education and learn the material needed for the course" "A good classroom is when the students and instructors each make conscious efforts to facilitate learning" "Encourage asking questions in class by balancing formal and informal methods of delivering material"
Peer and Instructor Feedback	62%	"Teamwork is vital to a strong learning environment. You learn less from yourself than you do from others." "Construct detailed assignments that accurately reflect students' success at a given point in the course." "Give constructive feedback on assignments and in-class activities, especially multistep processes."
Bringing and Inclusive Mindset	67%	"Give students multiple opportunities to show their knowledge and gauge their understanding of the material." "Respectful of all students from all backgrounds ○ Be sensitive to diversity, equity, and inclusion issues ○ Do not allow anyone to be disrespectful towards other students" "Creating a safe space for students to learn and also share their opinions on topics where they won't be uncomfortable or judged. I think this is important because it allows the chance to hear and learn from other students' opinions without being made fun of. And I think that when these conversations are reinforced with inclusive dialogue, it provides a more comfortable and engaging learning environment."

Results from Teaching Philosophy Statement (End of the Semester)

Using the topics introduced in the course as the baseline constructs, themes were derived from each of the students teaching philosophy and classified accordingly as they were either directly or indirectly mentioned. These included Evidence Based Teaching, Peer and Instructor Feedback, Developing and Facilitating Effective Teaching, Bringing An Inclusive Mindset, Active Learning, Assessment of learning and Ethical/Social Responsibility.

Evidence Based Teaching

Students expressed various facets of value and importance of utilizing evidence based teaching in their classrooms. For example, one student felt

"While I value innovation and experimentation as a teaching fellow where appropriate and in a very controlled manner, day to day interactions with students benefit them the most when teaching methods which have been proven time and again to benefit the students being taught."

- *Third year Male Computer Science*

Authentic teaching and learning:

A highly mentioned sub-theme was connecting their teaching to "real-world" or "real-life"situations. Students not only reflected on what worked for them, but how they understood the research showing a positive increase in learning and motivation when using authentic problems in engineering and computing classes.

"*As such I fill in the gaps by encouraging my students to think about concepts being taught in terms of real-life situations, not just in terms of computers. Being told to solve a problem that was specifically designed to fit the material doesn't encourage out-of-the-box thinking and therefore doesn't foster creative problem solving or creativity, two very important aspects of computer science."*

- *Third year Computer Science*

Teaching Techniques

Teaching fellows even discussed some techniques like using software such as CATME and collaborating during class to help facilitate engaged learning.

"...I hope to incorporate time in class for students to collaborate on concept maps prior to exams. I would also begin lectures with a five minute discussion between students in groups of four to five to write a list of any questions they have regarding the material from the previous class or from any at home readings or homework. Students can connect concepts in this way."

- *Fourth year Female Chemical Engineering*

Developing and facilitating effective teaching spaces

Understanding the need to create a safe and thriving environment for students was an important aspect with the teaching fellows. They reflected on times they felt they were unable to ask questions, experienced a negative failure culture or felt alone in their learning.

Safe Spaces

Many of the teaching fellows wanted their own students to feel they are an ally and foster positive learning experiences through the creation of a safe space.

"In my teaching philosophy I believe that everyone has the potential to be successful under the right intrinsic and extrinsic conditions and this can be facilitated by creating a classroom that is a safe space where students can feel included, heard, and explore their interests."

- *Third year Male Chemical Engineer*

Positive Failure Culture

Failing, whether it be an exam or not understanding the material, has become a problem that causes students to disengage or even leave their major unnecessarily. Reinventing and creating a positive failure culture is compulsory for a successful classroom [9].

" During the beginning of the semester especially, I would let students know that it was alright to not know what is going on and to stop me if what I am saying makes no sense."

-4th year Male Computer Scientist

"I will provide the necessary feedback when grading for the students to learn from their mistakes while not punishing them too harshly for making small errors."

- *4th year Male Mechanical Engineer*

Peer Mentoring

Students also felt that mentoring was also vital to their students' learning. They discussed being open and vulnerable about their experiences:

"Another way I like to provide reassurance to my students that they can be successful is by acknowledging my own struggles in taking introductory-level courses. I needed to retake CMSC 201 the first time because I fell behind but fast forward a few years later and I'm a teaching fellow for the class as well as an aspiring software engineer. Showing that humility encourages students to be more open to trying and possibly failing if they know there's always a chance for redemption."

- *4th year Male Computer Engineer*

Peer and Instructor Feedback

During the class discussions, TF's expressed their own desires to know their performance in a class. Beyond normal grades and exams, they desired for more creative solutions and less intimidating ways that would help them and their students professional development. They expressed wanting more ongoing and continuous constructive feedback.

Beyond just exams, I want to do weekly reflections with students to give them the opportunity to look back on their learning system and make changes as necessary.

- *Fourth year Male Chemical Engineer*

Problem-solving learning environment, it is important to give students sufficient time to complete the problems and substantial feedback on the work done.

- *Fourth year Male Computer Engineer*

Bring An Inclusive Mindset

One of the core values of UMBC community is to *"...redefines excellence in higher education through an inclusive culture that connects innovative teaching and learning…[10]"* Students at UMBC university receive this messaging at the start of their academic career. In this seminar class, the teaching fellows deeply discussed and reflected on their own teaching defining what it meant to have an inclusive and empathic classroom.

Diversity, Equity, Inclusion and Accessibility

"I appreciate the importance of diversity in the classroom. Representation of students yields comfort in the classroom, which creates an environment for learning."

- *4th year Male Chemical Engineer*

"Creating and supporting an inclusive community encourages students to engage in material and build study groups. My undergraduate chemical engineering program excelled at community building. Diverse groups were promoted within many of its core courses, preparing students for collaboration in the workforce."

- *4th year Female Chemical Engineer*

"This is the diversity of students, which I keep in mind when talking to students or answering their questions. I never want to unintentionally talk down to a student of a different background because of an implicit bias."

- *4th year Female Mechanical Engineer*

Empathy

Some of the teaching fellows even reflected empathy towards students who were in challenging situations. Specifically one teaching fellow addressed the potential of the different backgrounds and situations of his students and its impact on their students' learning environment.

"Some students are living away from home for the first time, some people are first-generation college students, some people are international students, and some like myself picked a major and constantly struggled with imposter syndrome……This type of pressure makes students(especially first-year students) feel overwhelmed to the point that they either give up (by dropping the class or just not showing up anymore) or cheat. Likewise, other less extreme

experiences students face when going through first-year gateway requirements are skipping meals, sleep deprivation, and failure to keep up with personal hygiene."

- *4th year Male Computer Engineer*

Active Learning

At UMBC, students are introduced to the practice of active learning in their first engineering and computing classrooms. This teaching methodology is so familiar, it's often found as a part of UMBC, not only faculty and students, but even non-teaching faculty and staff's vocabulary. However, in this class, the teaching fellows were introduced to the research around active learning and why it's so effective.

"While this has already been well-proven by both scientific and empirical evidence, it's worth mentioning: Active learning is one of the major keys to success for students. I am a firm believer in the idea that students are capable of learning when they are given a basic background knowledge and "set free" on a problem."

-4th year male mechanical engineer

"I make clear on the first day the expectation for students to come to class prepared (be that by reading the textbook, watching videos, etc.). Then, the lecture time is devoted to active learning activities. This involves open-ended problems and group activities."

- *4th year Male Chemical Engineer*

"Teaching students efficiently is by facilitating active learning. While direct instruction is an effective and evidence based method, to many students, it can sometimes just feel like a bland lecture. Getting the students to engage is an important part of delivering a meaningful mini-lecture."

- *3rd year Male Computer Scientist*

Assessment of learning

Diversification of class assessments was mentioned by 30% of the teaching fellows. More emphasis on this topic will be introduced and practiced in their Engineering 397 seminar class.

Formative and Summative assessments

"Some ways I assess teaching effectiveness is through in-class practice problems, quizzes,homework, and group projects. In-class practice problems are meant to reinforce what has already been taught and is an effective way to know what students have learned and what they struggle with so I can intervene. Quizzes and exams are also useful to test student comprehension and is the only assessment method where students cannot get feedback prior to submission."

- *3rd year Male chemical Engineer*

Ethical/Social Responsibility

Ethical and Social responsibility were the least highlighted in the statements. Students at UMBC are continuously exposed to this topic within their educational pathways in engineering and computing. The instructors of the course plan to re-evaluate the dissemination of this material to help students connect better with the topic.

Future work

Continuous work is being done to assess the impact and development of Engineering 396 and 397. Currently, a new cohort of students are registered for the Engineering 396 class and around 85% of students who completed Fall 2022 396 were retained in 397. In this class students are peer mentoring 396 students, engaging in a semester-long research project, lead one of the discussion activities in 396, peer assess a discussion class, and attend a couple of advanced scholarships in teaching and learning opportunities. Both sections will be attending a Teaching and Learning Symposium offered internally through the Provost office and faculty development center.

Future analysis will include a deeper exploration of the impact of this certification on the students' development. This will include the following:

- Interviews with the students around their teaching philosophy.
- Examination of the new 396 cohort philosophy and 397 newly developed philosophies
- Impact analysis on motivation, attitudes, self-efficacy on the students and their career
- Impact on analysis on confidence and success in their respective courses as teaching fellows through observation and qualitative assessment.
- Assessment and evaluation of research projects

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Appendix A
In this course, the outcomes align with the mission and learning outcomes of the Center for Integration of Research, Teaching, and Learning (CIRTL) [8]. Students will, in a two semester course sequence, participate in various activities around the following topics:

Teaching-as-Research

- Describe how to access the literature and existing knowledge about teaching and learning issues, in a discipline or more broadly.
- Define and recognize the value of the Teaching-as-Research process, and how it can be used for ongoing enhancement of learning.
- Describe a "full-inquiry" cycle.
- Describe how the integration of Evidence-Based Teaching, Learning Communities and Learning-through-Diversity within Teaching-as-Research can be integrated to implement and advance effective teaching practices for diverse learners.

Content

Evidence-Based Teaching

- Describe and recognize the value of well-defined, achievable, and measurable student-centered learning goals.
- Describe several known high-impact, evidence-based effective instructional practices and materials and recognize their alignment with particular types of learning goals.
- Describe several assessment techniques and recognize their alignment with particular types of learning goals.

Learning Communities

- Describe and recognize the value of learning communities, and how they impact student learning.
- Describe several techniques for creating a LC within a learning environment, including strategies that promote positive interdependence between learners so as to accomplish learning goals.
- Describe several techniques and issues of establishing LCs comprising a diverse group of learners.
- Recognize the value of and participate in local professionally-focused learning communities associated with teaching and learning.

Learning through Diversity

- Describe the scope of diversity in learning environments, of both students and instructors.*
- Describe the impact of diversity on student learning, in particular how diversity can enhance learning, and how inequities can negatively impact learning if not addressed.
- Describe how an instructor's beliefs and biases can influence student learning.
- Describe and recognize the value of drawing on diversity in the development of teaching plans (including content, teaching practices and assessments) to foster learning.
- Describe several learning-through-diversity (LtD) techniques and strategies.