I endeavor to be an inspiring and effective educator, given that I will teach the next generation in a position of great privilege and responsibility. In the current era, with access to an overwhelming amount of information, critically evaluating, analyzing, and harnessing it are skills required to overcome challenges successfully. I aspire to create an environment where students can develop and practice these skills. I have extensive teaching experience as an undergraduate and graduate Teaching Assistant (TA) at the Universidad de los Andes (Colombia) and Carnegie Mellon University (CMU), where I have received excellent student feedback and teaching awards. Moreover, I have designed and led a graduate course on Quantum Integer Programming (QuIP) for students across diverse disciplines. Below, I elaborate upon my teaching experience, philosophy, and interests.

Teaching Experience

As an undergraduate student, I volunteered as a TA and grader for several lectures across the Mathematics, Physics, and Chemical Engineering departments. The departments involved offered these positions only to students who excelled in the given courses and were genuinely interested in helping their peers through their learning process. Not long after, as part of my M.Sc. degree fellowship, I led recitation sessions for two different classes. One focused on process optimization, which my research advisor taught, and had a computationally-oriented recitation. The second class was focused on the analytical treatment of thermodynamics. For each class, I oversaw course material development, lectures, and grading. These two courses allowed me to handle different class environments, leveraging the various pedagogical tools tailored for each situation. As a Ph.D. student at CMU, I worked four times as a TA for three courses. These courses were the undergraduate senior process design course (twice), the graduate core advanced process systems engineering (APSE) course, and the special topics graduate course of disjunctive programming. My duties included grading and offering office hours. Still, thanks to the instructors' disposition, I proactively pursued opportunities to improve my in-class teaching skills by giving recitations and guiding the students through their assignments. Following my TA assignments, I was asked by the main instructors to give invited lectures in their classes, both in the Chemical Engineering Department and outside of it, highlighting the quality of my previous TA appointments.

Each year, CMU's Department of Chemical Engineering presents the Mark Dennis Karl Outstanding Graduate Teaching Assistant Award to one doctoral student who has demonstrated excellence as a TA. For my TA assignment in the process design course, I was nominated in 2018 and received this award in 2019. Although I am very proud of this achievement, what is more valuable to me is the students' acknowledgment; hence, I was profoundly moved when I learned about the comments that students submitted in support of my nomination. One of them wrote, "*I think that David Bernal is the most deserving recipient of the TA award. He was always available whenever we needed help with anything and really went above and beyond with everything he did.*"

As part of the undergraduate senior's process design lectures, I supervised on each occasion several groups, serving as their advisor for the final project. This experience taught me the value of enthusing students' learning while addressing each group member's strengths and weaknesses to achieve the best performance. The core graduate lecture taught me how to communicate complex concepts to students who, contrary to me, considered the material valuable but not essential for their work while making it approachable and entertaining. The special topics lecture, to which I was personally invited to be the TA by Prof. Egon Balas†, showed me how a highly specialized graduate-level class needed to be taught by making cutting-edge material in the topic accessible to those taking the course.

In addition to the hands-on experience I gained while teaching these classes, I joined CMU's Future Faculty Program to learn more about the research-based principles of pedagogy and effective course design. Teaching consultants observed my lecturing in the classroom, accompanied me in a project to design a new course, and gave me feedback at every step, allowing me to reflect on my teaching. Based on that feedback, I developed a new course, adapted my lecturing pace to one that allows for efficient information retention, and adopted new technologies tailored for virtual learning environments.

I applied all these tools as one of the lecturers of an entirely novel Quantum Integer Programming (QuIP) course during the Fall of 2020. Leading, designing, and delivering several modules of this course, an

uncommon opportunity among Ph.D. students at CMU, was an exceptionally fulfilling step in my teaching journey. Addressing diverse audience backgrounds across engineering, computer science, mathematics, and business, communicating novel content from the technical and pedagogical side, and exploiting the opportunities given by remote learning were among this process's most challenging and rewarding experiences. This course has received outstanding feedback from students and the university[i].

Another form of teaching is mentoring, which I enjoy because of its more personalized approach. During my time at CMU, I was privileged to supervise four undergraduate and two master's students in their research through weekly one-on-one meetings focused on reviewing their progress, providing feedback, and hands-on working sessions. This mentoring experience has taught me important lessons. The first one is that motivation is the primary driver of progress, and its source can differ for each person. The second one is that a mentor's mission is to guide the mentee in the direction where their particular talents can be harnessed best.

Each of these experiences was unique and provided me with learnings reflected in my teaching philosophy.

Teaching Philosophy

My key teaching goal is to be the catalyst for students to grow into independent learners, supportive team members, and critical thinkers. I am convinced that these traits enable them to take the material learned in the lecture and deploy it in applications outside the classroom. The five guiding principles that I apply in my teaching to achieve this objective are explained below.

To inspire a positive learning experience, I bolster students' enthusiasm for **learning**. Capturing the students' attention is crucial in engaging them and ensuring a successful educational experience. One way of achieving this goal is by using real-life examples and drawing parallels to concepts and experiences that the students are already familiar with. For instance, in the process design class, I presented statistics and occurrences of actual incidents in the chemical industry. I highlighted concepts covered in the course that could have been used during the design process to avoid them, emphasizing the importance of process safety considerations during all conceptual design phases. I gave this lecture during my first time as the process design TA, and a year later, I was invited to repeat it during the semester's first session, given the students' excellent feedback.

I **encourage active learning** by endorsing the students to appropriate the topics taught and apply them in their own context. This not only reinforces the students' enthusiasm but promotes their creativity when seeing the lessons learned as tools to apply in any relevant situation. Moreover, I invite them to interact with me in and outside class. The involvement improves the course's overall quality by incorporating their suggestions, steering its delivery towards their interest, and fostering a sense of ownership for the lecture and content. In my opinion, this active engagement of the students leads to the most effective way of learning: by doing and teaching others how to do. For example, in the QuIP modules, I recommended students choose an application of their interest to be tackled for the final project using the concepts learned in class. Given the different backgrounds of students in the course, we had a broad range of project topics, such as cyclopeptide detection, subatomic particle tracking, and process scheduling. This was a fantastic learning experience for everyone involved, including myself, because it exposed how various applications could be addressed using the tools acquired in the lecture.

Teaching a wide range of populations has trained me to be **clear and consistent with the course material while being flexible to individual needs**. This strategy provides students with well-prepared material for reference and acknowledges each person's differences when faced with new learnings. For that, it is necessary to have a well-defined course structure where the teaching methods, learning objectives, and assessments are clearly established and closely aligned. While being consistent as a lecturer is crucial to improving learning outcomes, I allow my students flexibility. This was an important lesson I gained after being the TA for the core graduate APSE lecture. Most students were recently incoming graduate students from all over the world with different backgrounds. This lecture proved challenging for some of them, being the first on advanced chemical engineering optimization methods. To address this situation, I offered extra office hours and introductory sessions to level up all the students and committed to their success in the

course. Despite the diversity of background knowledge, all students passed the class, and several joined research projects within Process Systems Engineering.

Beyond a teaching philosophy, part of my life philosophy is that **making others grow is a way of personal success**. Following this, developing others' knowledge and talents is a way for my own personal development. This drive was one of the main motivations for designing and offering a new QuIP course. Having a monopoly over a novel topic's expertise might seem like an advantage to others, although I consider sharing that knowledge a duty to society's progress. This lecture allowed students to enhance their own research projects by incorporating quantum computing as a novel tool to their skill set and showed me how to advance their own interests and research further using this novel topic.

Furthermore, our society's current and future challenges are too complex to be addressed by a single discipline; therefore, one important lesson I endeavor to impart is **working efficiently in teams**. As a TA, I experienced advising groups for the senior process design and the APSE final projects. These two semester-long efforts showed me how much students learned, not only about the class material but also about team and talent management. They inspired me to implement a similar approach when designing the QuIP course final project, which consisted of applying quantum computing to innovative science and engineering applications. Groups of students from different departments and backgrounds were formed, balancing and exploiting each member's capabilities. I provided regular feedback based on weekly short update presentations, ensuring constant progress, and resulting in a successful learning experience.

I am devoted to addressing individual needs and recognizing diverse skills as I consider developing others an effective way of engaging equal opportunity and diversity. I engage in identifying knowledge gaps based on every student's performance and behavior and proactively address them. I also encourage students to approach me directly with particular concerns. Similarly, I am happy to provide students interested in exploring the course topic further with additional material and possible research opportunities. This is part of my philosophy since teaching is integral to establishing and managing a successful research program. Finally, I acknowledge the need to **learn and innovate in my role as an educator continuously**.

Teaching Interests

Considering my background, I am well-suited to be the lecturer of a range of courses within the Davidson School of Chemical Engineering at Purdue University. Regarding the current undergraduate curriculum, I am particularly interested in teaching CHE 45000 - Design and Analysis Of Processing Systems. Additionally, I would be happy to teach other courses from this program, such as CHE 21100 - Introductory Chemical Engineering Thermodynamics, CHE 30600 - Design of Staged Separation Processes, and CHE 59700 System Analysis of Energy Production. I look forward to supporting the Energy and Environment undergraduate concentration area.

I am also thrilled by the possibility of teaching at the graduate level. Among the existing courses, I could teach courses such as CHE 55000 - Optimization in Chemical Engineering (my main research area), CHE 55500 - Computer Integrated Process Operations, and CHE 55800 - Rate-Controlled Separation Processes. I would also be excited to design and teach new elective courses focused on the methods from Advanced Process Systems Engineering, their intersection with novel computational methods for optimization, and their application in Chemical Engineering. I am also ready to lead a course built on QuIP, which I have already developed and taught. This course would complement the department's efforts in Process Systems Engineering by teaching students to exploit unconventional computational paradigms, e.g., Quantum Computing.

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[i] [1] https://www.cmu.edu/tepper/news/stories/2020/october/quantum-computing-course.html