Georgia Tech College of Sciences
School of Chemistry and Biochemistry

January 28th, 2024

Dear Selection Committee Members:

It is a pleasure to support the nomination of Dr. Anh Le for Georgia Tech's "Innovation and Excellence in Laboratory Instruction Award". Dr. Le is a passionate colleague, with a great love of physical chemistry who seeks to develop that love in her students. I have known Dr. Le since she arrived at GT in January 2021, and I have a good knowledge of her instructional activities, as she reports to me and we talk frequently. We hired Dr. Le because of her excellent background in experimental physical chemistry and her prior experience teaching it. However, her duties at Georgia Tech are split between teaching our physical chemistry laboratory course once every Spring semester and leading multiple lecture sections in our First Year Chemistry program.

CHEM 3481, Physical Chemistry Laboratory, is a 2-credit lab course taken by all of the Chemistry majors seeking an ACS (American Chemical Society) certified degree, which amounts to ~30 students each Spring, although this number is growing. When Dr. Le arrived on campus in 2021, many components of the student experience in this course looked very similar to what I did ~40 years ago as a chemistry undergraduate, and much of the laboratory instrumentation was outdated. As Dr. Le starts her 3rd independent offering of this course, her (very positive) influence on the course is clear, as I will outline below.

Dr. Le has restructured the course to better align it with our desired learning outcomes, and to better support student success. A dedicated lecture prior to embarking on lab work has been introduced, so that students have a much clearer understanding of what they will be doing, why they are doing it and the safety considerations regarding their work. Key components of the prelab content are reinforced at the beginning of each lab period by TAs. New online instructional materials, designed to bring all students "up to speed" in the use of Mathematica and Python, for data analysis, have been put in place. All of our CHEM majors take a Python course to meet the Institute's "Core A" requirement, but their skills can be rusty by the time they take CHEM 3481, and some of my colleagues use Mathematic to support the prerequisite physical chemistry lecture classes. However, Mathematica is not uniformly used by all of our lecture instructors! The requirements for laboratory reports have been restructured so that we do not place too great a time burden on students taking this 2-credit class, while still properly preparing them to write high

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quality reports. They only write full lab reports for shorter experiments, and abbreviated reports are prepared for longer experiments, or experiments with very involved data analyses. Initial data analysis is done in class, in the presence of our teaching assistants, so that any conceptual and procedural issues associated with the analyses can be address before the students leave and complete their reports.

All of the experimental components of the course have been revisited and many replaced or refreshed. To facilitate this, Dr. Le has partnered with colleagues to write successful technology fee proposals for new equipment. These proposals have so far resulted in two new fluorescence spectrometers, which have been deployed to good effect, a set of new "bomb" calorimeters, and a laser that is being incorporated into a "home brew" Raman spectrometer. In this context, "home brew" is pedagogically good. We want our students to develop some basic instrument design and construction skills, and you do not get that if all they see and manipulate are commercial "black box" instruments. A student "project" has been introduced into the class, so that student groups get the opportunity to design procedures, measurements and data analyses to accomplish a goal, rather than just following protocols. This appears to have been very well received. Dr. Le is in the early stages of incorporating an instrument construction project into the course, where students will build their own spectrometers from commercial components – this is a common activity for practicing professional physical chemists!

In summary, Dr. Anh Le is a strong candidate for the "Innovation and Excellence in Laboratory Instruction Award". She is a passionate, innovative and student-centered educator. Her transformation of an antiquated physical chemistry laboratory course into a modern well designed and effective course is well advanced.

Yours sincerely,

A. P. Wilkinson

Angus P. Wilkinson
Assoc. Chair and Prof. Chemistry and Biochemistry
Prof. Materials Science and Engineering

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Statement for CTL Innovation and Excellence in Laboratory Instruction Award

Motivation:

By its very nature, chemistry is a experiential science, and there is no better venue for stimulating those sensory experiences than in the laboratory. To garner a working understanding of chemistry, students require the hands-on experience of designing and implementing modern experiments. Throughout my teaching experiences, I have come to realize that for many students, there is a significant disconnect between what is presented in lecture courses or small group discussion settings and what is hopefully experienced in the laboratory. Although essential to learning chemistry, the laboratory experiences are often devalued as part of the educational experience. Upon arriving at the School of Chemistry and Biochemistry at the beginning of 2021, I made it my mission to enhance students experience in the lab especially in CHEM3481-Physical Chemistry Laboratory (Pchem Lab) via developing new, thought-provoking and interactive experiments for the "laboratory courses" in Physical Chemistry or independent research projects.

Challenge:

The innovation of CHEM 3481 - from my point of view is challenging for many reasons:

1. Many of the instruments in the lab were either old or shared between CHEM 3216. Previous Lab Coordinator, Dr. O'Mahony was running three laboratories at a time. So, the lab schedule, instruments usage was coupled with CHEM3216 schedule.
2. Physical lab is only offered once per year – a spring only class - so most of the innovation/new experiments for the lab has to be carefully thought out, and constantly tweak during the time the lab is offered. Some of the innovations are not seeing the result until the next year.
3. Teaching Assistant (TA): The problem with TA for CHEM 3481 is not about the number, it's about the right TA for the job. Unlike general chemistry (CHEM1XXX) or Quantitate analysis (CHEM2216L), where you can maximize utilization of your undergraduate TAs (UTAs), or any Graduate Teaching Assistant (GTAs), the TAs problem in CHEM 3481, it's unique. Since CHEM 3481 only offer once per year, a lot of my TAs are either graduating (UTA and GTA), or does not have to teach the following year, making it difficult to train the TA.

From the student point of view: students often think of Physical chemistry lectures and laboratory are "scary". A lot of students are afraid to take CHEM 3481 because it's required the deep understanding of quantum, mechanics, thermodynamics, statistical quantum mechanics. All of these topics require advanced mathematical understanding for data analysis, data interpretation. A lot of students struggle with the concept of generalizing form microscopic point of view (behavior of atom, molecules) into macroscopic point of view (heat capacity, enthalpy, Internal energy). On top of that, CHEM 3481 laboratory experiments frequently involve sophisticated

instrumentation such as spectrometers, calorimeters, and lasers. Learning to operate and troubleshoot these devices take times and may not be feasible during a single the lab period.

Redesigning the course structure

Facing these challenges, and with the goal of making CHEM 3481 a more enjoyable course, I began the process of redesigning and rebuilding the lab as soon as I arrived at Gatech. I started by learning how the lab was operated in the past, deciding on what worth keeping and identify elements that were no longer working effectively for modern Physical chemistry laboratory.

One of the initial steps I took was to coordinate with our course scheduler, Dr. Pamela Pollet, to reinstate lab lectures. The week of CHEM 3481 starts with lab lecture on Monday where I deliver all the lab content of the week, follow by the lab sections from Tuesday - Friday. The purpose of the lecture is to: answer questions pertinent to performing the experiments and the preparation of lab reports, provide background material relevant to the understanding the experiments, discuss proper data analysis techniques and report preparation. This ensures that the students have all the background information that they need to begin the experiment, analyze the data. The students then go on to their lab section which runs by TAs from Tuesday – Friday. At the beginning of each lab section, TAs also gives a short 10 minutes overview. The repetition helps to ensure the deliverable materials to students.

Concurrently with reinstating lab lectures, I removed the previous rotation structure of the lab. The rotation structure required instructors and TAs to keep track of multiple ongoing experiments simultaneously, hindering peer support for data analysis discussions among students. By only running one experiment at a time, the instructor and TA can focus more, staying on top of the materials in order to assist students to master the lab content. At the same time students will have support from their peers, they will have the opportunity to work, discuss the lab materials together during lab and outside of the lab.

Once the main structure was in place, I work on update the details of each experiment to eliminate unnecessary tasks and allocate more time in the laboratory, enhancing students' efficiency during lab sessions. I employ and optimize computer usage in the lab by incorporating a homemade automated recording program, adding an analysis program, and streamlining operational steps. This is done to enhance the overall laboratory experience.

Upon reevaluation, I have refocused the Physical Chemistry laboratory protocol by removing certain synthesis components. This adjustment aims to help students concentrate on the core emphasis of the Physical Chemistry Laboratory.

All of these changes were implemented through a multi-step process.

Funding for new equipment, instrumentation.

Over the course of three years, Dr. Christy O'Mahony and I collaborated to secure approximately $155,000 from the Tech Fees internal fund. This funding was directed towards acquiring equipment beneficial for both CHEM 3481 and 3216L. The majority of the funds were allocated to the purchase of two Horiba-Duetta Fluorescence and Absorbance Spectrometer,

serving a crucial role in experiments such as the Photochromic experiment and related student projects. Notably, a sum of $32,800 was dedicated to obtaining four bomb calorimeters specifically for the Physical Chemistry laboratory. The newly acquired state-of-the-art instruments are designed to be compact and versatile, facilitating easy mobility between labs and convenient storage when not in use.

In addition, an extra $5,000 was secured from the School of Chemistry and Biochemistry in Spring 2021. This funding was utilized to replace an output coupler for an old ND-Yag laser, providing the Physical Chemistry lab with its own cutting-edge research laser. I anticipate the completion and deployment of a homemade Stimulated Raman spectrometer in Spring 2024.

A grant of $7,000 from the School of Chemistry and Biochemistry's year-end seed for the Fiscal Year of 2022 was also awarded. This grant specifically supports the acquisition of laptop/desktop computers for the Physical Chemistry lab, contributing to the enhancement of the overall laboratory experience.

Hand-on Experiences:

1. *Homemade - modernized speed of sound:*

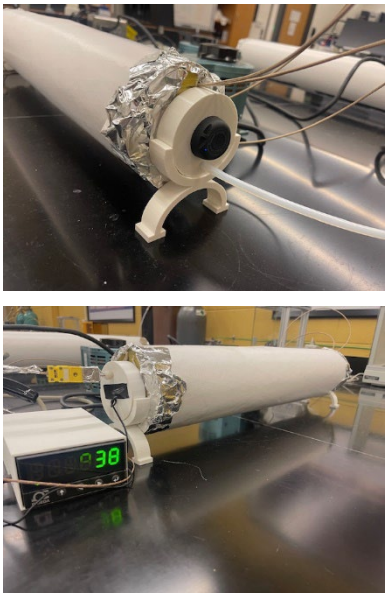

Figure1: Homemade speed of sound tube.

The speed of sound, a fundamental property of acoustic waves, characterizes the velocity at which sound propagates through a given medium. This parameter holds significant relevance in various scientific and practical applications. For CHEM 3481, the determination of the speed of sound has evolved to incorporate contemporary technology. This innovative approach involves the use of cost-effective components such as aluminum tubes, insulated materials, 3D-printed caps, Bluetooth speakers, microphones, and audio recording and analysis software like Audacity. Remarkably, the total cost of each speed of sound set up is about $150 which make is very accessible for collaborative effort between a pair of students. Despite its cost-effectiveness, the accuracy of this setup is impressive, achieving precision within 1% of the measured speed of sound of Helium gas reported in the literature. The experiment extends beyond the speed measurement, it is also help determining heat capacity ratio as well as heat capacity under constant volume. The experimental values when comparing with the equipartition theorem and statistical quantum mechanics models provide the insight into the connection between microscopic and macroscopic worlds.

2. *Photochromism using "Spaceship" Fluorimeter:*

Photochromic substances undergo reversible changes in their molecular structure by exposure to light, typically ultraviolet (UV), resulting in a visible alteration of color to transparency. One of the most common applications photochromic materials is transition sunglasses which is darken in response to sunlight and lighten when the exposure is removed.

Figure 2: Horiba – Duetta Spectrometer

The kinetic experiment involving the photochromic reaction from the normal state to the metastable (M) isomer is studied using Horiba Duetta-Fluorescence and Absorbance Spectrometer. The experiment typically begins by preparing a solution containing the photochromic compound in its normal state. This solution is then subjected to UV or visible light irradiation; CHEM 3481 students often call this lab is a "*Disco lab*" because we use the photographic flash light as a safe and inexpensive UV source to turn the normal isomer into the metastable isomer. Utilizing the capabilities of Horiba instrument as well as its temperature control feature, an absorbance vs time was measured as well as the temperature dependent aspect, as the results the activation energy between the two isomers was reported.

3. Bomb calorimetry

Unlike the first two experiments, where modernized approach was taken, the bomb calorimeter is the classic physical chemistry laboratory experiment. However, to my surprise, Gatech did not have a set of bomb calorimeters for Physical chemistry laboratory. I succeed secure the funding to purchase four (4) bomb calorimeters coupling the bombs with digital thermocouples, utilizing LabVIEW programing for auto-recording data. Beside doing standard procedure with benzoic acid and sugar, students were excited to run the combustion experiment on gummy bears and compare the results with the nutrition label. are forthcoming, and students are intrigued to see that the internal energy seems to match with the nutrition label on the gummy bear package.

Figure 3: Bomb calorimetry set up with gummy bear sample

4. Stimulated Raman

Stimulated Raman experiment requires a more thoughtful process since it is involved class IV laser. The experiment's design has to be approved by our Laser Safety Officer to offer an insightful but safe environment. In the end, we were able to come up with bench top enclosure with a laser-

rated plexiglass to ensure that the laser path was contained, but student was able to view the inside from the top down. It's important to be able to show the student all of the moving components such as: laser, mirrors, lens, spectrometer, sample cell of the *"black box"* design. This simple set up will tap into student's curiosity and their creative side.

5. End of semester project

I started implementing a final project last year where I selected an article from J. Chem. Ed and ask the student to do two things: 1. Reproduce what was presented on the paper, 2. Propose an add-on experiment they would like to conduct to further build on the results from the paper. Students then present their results as the group project. This is very important for an upper division course because it serves as an assessment on the top tier of Bloom's Taxonomy, the "creative" tier. Students would learn how to manage their time for experiment projects, plan the experiments, work in groups, proceed with the experiment. It is also important to show that they have many great ideas, but these ideas must be practical within the limited amount of time. In the end, there was a lot of interesting results on their add-on experiment.

"Less is more" model:

1) Introduction of a mixed between full and hybrid lab reports.

I offer variety of type of the lab reports to address different components of the lab. If the experiments are difficult and take longer to run, and less challenging in analysis, the lab reports will be full writing with all the components: Abstract, Introduction, Experiment, Result and Analysis, Discussion, Conclusion, Appendix. Examples of these experiments is: "Heat of combustion-Bomb Calorimetry", "Differential Scanning Calorimetry of Polystyrene", "Kinetics of photochromic reaction". If the calculation is very difficult and lengthy, then the lab report is either in the format of form or hybrid where student either answer questions or only write 1 part of the report only. These experiment for the hybrid reports are: "speed of sound – heat capacity ratio", "Quantum Dots", "Computational of Binding Energy", "Normal mode analysis of CS_2".

2) Participation form

The participation forms for each experiment were specifically designed to mandate that students complete during the laboratory period. These forms typically are tables that students would need to construct their lab reports. The intention behind this design is to minimize the amount of time students need to dedicate outside the lab to complete their reports. As per the CIOS (Course Instructor Opinion Survey) scores, on average, students spent approximately 8.3 hours per week toward CHEM 3481. This includes both the lab session itself and the corresponding lecture, totaling 6 hours. Consequently, the time students spend outside of lab is mostly on the lab report, is reduced to an average of 2.3 hours per week. This streamlined approach aims to optimize students' efficiency and learning experience within the confines of the laboratory.

3) Videos tutorials:

When applicable, I have incorporated instructional videos as tools to enhance the learning experience through practical examples. Two notable examples include the "Mathematica tutorials" and the "Python_google colab tutorial."

The “Mathematica tutorials” serve as valuable resources. Mathematica is the program that often use in Physical Chemistry Lecture; however, many students use this for the first time. By having access to these materials early on in the semester, students then can learn by example via following the provided Mathematica notebook for an exercise in the lab. By watching the video, following an example, and finish the exercise, by the first week of the lab, most students were more comfortable with using the software.

“Python_google colab tutorial” on the same topic was to take advantage of the fact that many Chemistry student has gone through Python classes in freshmen year, this is a quick review, as well as showing student resources that sometime student can do calculation at anytime, using any device.

Summary and Future Work

The innovation of CHEM3481 is an ongoing process, evolving along the side with the increasing accessibility to technology. I aim to introduce more hand-on projects, with the goal that that the student can learn these transferable skill-set that extend beyond the laboratory setting to real-life application.

As part of the First Year Chemistry (FYC) Faculty and serving as the CHEM 3481 lab coordinator, I find myself navigating both ends of the spectrum. As student advance through various chemistry laboratory courses, they encounter different expectations, distinct writing styles for lab reports, and varying emphases. These differences are understandable given the diverse nature of expectations across different disciplines within chemistry. However, I've observed that these variations can lead to frustration among students. In my view, despite the distinct nature of each lab, there is merit in designing the entire chemistry laboratory curriculum as a unified entity. This approach aims to provide students with a more cohesive and beneficial progression, allowing them to gain insights from different perspectives rather than experiencing frustration due to inconsistent expectations.

Laboratory experiences are not a one-time, standalone occurrence; rather, they involve a cumulative buildup of knowledge from First Year Chemistry (FYC) to upper-division chemistry. Each laboratory teaches students something important. Rebuilding the chemistry laboratory curriculum at Gatech to cooperate every discipline take time and effort. This requires all division works together to build a curriculum that everybody agrees. This also helps eliminate some of the redundancy between each laboratory. For example: upon discovering that the FYC laboratory already provides coffee cup calorimeters, I decided to eliminate the heat of reaction (which falls

within the same category as the coffee cup) and introduce the Bomb Calorimeter. Insights gained from involvement in the FYC laboratory were crucial. Similarly, upon learning that CHEM 3380 already covered the synthesis of Quantum Dots, I shifted the focus of the CHEM 3481 quantum dots laboratory to analyzing the data and concentrating on how students can use their data to understand lecture concepts like "Particle in the Box" and "Particle in the Spheres.", etc. These are only few of example that innovation of laboratory is not only about focusing on the specific lab assigned to teach but also about enhancing the entire curriculum.

Production of Teaching Tutorials:

Production of Teaching Tutorials:

These teaching tutorial helps student to either review Python or get up to speed with Mathematica.

- https://mediaspace.gatech.edu/playlist/dedicated/1_af5t6aih/

CIOS comments

Here are some student comments about the impact of CHEM 3481

Course best aspect:

On the experiment:

- Speed of sound (Candidate's comments: named of the homemade experiment)
- The experiments were fun

On the lecture:

- Going over the concepts for each lab before the lab was really helpful when writing lab reports. Lectures were clear and concise. i liked the lecture format
- The math was well explained and examples were show. In my experience, a lot of professors just give the what without fully explaining the why and expecting the student to determine that.

On the participation form and rubric:

- The participation assignments, while difficult, made me understand the material very well. They also prepared me for writing the lab reports.
- Finishing data analysis in lab let you actually research and understand further in depth the content
- The lab report rubrics were very helpful and I really appreciated them.

Overall effective

- I felt like it complemented the class well - it made me actually understand the concepts we learned in class (Candidate's comment: class here meaning the Physical chemistry lecture course)

Comments about student effort:

- Most relaxed lab class so far

Instructor greatest strength:

- She steered me in the right direction whenever I got lost in calculations.
- She was extremely invested in making sure students understood the material for the class and was always willing to explain things.
- excitement about the subject and availability if help was needed
- she was a great and effective communicator. Her lectures were easy to follow and provided great introduction for the labs
- Dr.Le was very good at explaining physics and pchem concepts that were understandable to those without a physics background Also she cares very much about her students

Georgia Tech College of Sciences
School of Chemistry and Biochemistry

February 2nd, 2024

Dear CTL Awards Selection Committee:

I am writing this letter in strong support of Dr. Anh Le's nomination for the 2024 CTL Innovation and Excellence in Laboratory Instruction Award. As a former recipient of this award myself, I cannot think of anyone more deserving of the award than Anh. She has transformed the Physical Chemistry Laboratory (CHEM 3481) course over the past few years and has a huge impact on our students and our School.

The Physical Chemistry lab course is required for all traditional track Chemistry majors and is also taken by most of our pre-health track Chemistry students. Prior to Anh's arrival at Georgia Tech in Spring 2021, I served as instructor of record for this course. At that time, the experiments in the lab were outdated with equipment and instrumentation badly in need of a refresh. During her first semester here, the lab course needed to be moved to an online format and Anh was able to immediately adapt the curriculum to allow this sudden change.

Now that Anh has taken ownership of the Physical Chemistry Lab and taught it for several semesters, the course is going from strength to strength. She is solely responsible for developing and implementing new experiments, training and coordinating teaching assistants (TAs), and upgrading the lab equipment. Anh has leveraged her expertise in experimental physical chemistry to enhance the lab curriculum with cleverly designed experiments that grasp student attention while focusing on rigor. She has both developed home-built instrumentation and purchased new equipment and instruments to bring the lab up to modern standards. These range from simple changes (replacing outdated mercury thermometers with digital thermocouples interfaced with software for a heat of reaction experiment) to complex (building her own laser-based Raman spectrometer). The overall effect has been transformative for the course and its students.

In addition to the redesign of the curriculum, Anh has increased the focus on rigorous data analysis across the lab experiments. Prior to her involvement, students performed experiments in the lab and worked up data on their own after hours. As data analysis is arguably the most important aspect of a physical chemistry experiment, Anh has coupled it much more closely to the measurements and students now perform their analysis in the lab with the help of their TAs to increase student understanding of this critical aspect.

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A particular challenge in the Physical Chemistry Lab course has always been training teaching assistants and ensuring that they are well prepared to assist students with the course content. The pool of available TAs rarely includes specialists in physical chemistry and non-specialist TAs view the discipline as difficult or overly complicated. Anh has worked incredibly hard to ensure that all TAs for the course are rigorously trained and able to help students with everything from theory to experimental technique to data analysis. In addition to benefiting the students in the course, this has provided incredible learning opportunities for those fortunate enough to teach the course with Anh.

Anh is extremely deserving of the CTL Innovation and Excellence in Laboratory Instruction Award. She puts the student experience at the front of everything she does and has truly transformed the Physical Chemistry Lab course making it hugely beneficial for all Chemistry students. Our School is fortunate to have a dedicated expert at the helm of this key course and it gives me great pleasure to express my highest recommendation of Dr. Anh Le for this award.

Sincerely,

Christy O'Mahony, PhD

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Dear Award Committee,

My name is Brady Sanders, and I graduated from Georgia Tech in December 2022 with a degree in Chemistry. During my time as a student, I was fortunate enough to take Dr. Le's Physical Chemistry lab (CHEM 3481). From my experience in all the labs I took, I can confidently say Dr. Le is the epitome of excellence when it comes to running her lab, and I am honored to write this letter of support for her.

Prior to enrolling in the course, I was nervous. Physical Chemistry was one of the classes that my peers and I feared because of the complex reputation it had. However, in hindsight, I had nothing to fear, as Dr. Le was able to demystify the complexity of the course while still maintaining all of its substance through her superior teaching abilities.

I think Dr. Le was so successful at teaching us this material because of the way she devised and taught her course. There are many things she did to make her lab stand out among the others, but three resonate with me most. First, she was a hands-on professor. I had professors in the past who would stop by the labs occasionally, but this was the extent of their lab interaction with us. Seeing her in our lab was not the exception, but the norm. She would make herself available for us whenever we had questions but ensured that she did not simply spoon-feed us answers; she maintained a perfect balance between challenging us and helping us, to make sure we never gave up. This hands-on approach was also seen when she devised her labs. She would update her labs yearly to ensure that we could learn as effectively as possible. The lab that stands out most to me was the Speed of Sound experiment. This was a homemade experiment that really allowed us to interact with the material and instrumentation in a way that allowed us to more fully comprehend the scientific processes that occurred and allowed us to get a deeper appreciation for the material.

Second, Dr. Le devised prelab lessons that made us truly interact with the material before coming to the lab. While other labs also had prelab assignments, they were the run-of-the-mill "fill out your journal with the steps to do the experiment." While Dr. Le also required us to know the procedure before entering the lab, she went beyond to make sure we had a deeper understanding of the material by reinstating the prelab lectures; this was not taught in the years immediately preceding her instruction. This was helpful because instead of trying to learn the material for the first time in the lab, it reinforced the key concepts, allowing us to gain a mastery of the material.

Lastly, Dr. Le did a great job by incorporating software and code into the lab which allowed us to see how science interfaced with technology. Many of my other classes were so siloed and independent of each other that I could not see the broader picture and how everything connected. Her approach was truly innovative and not something I saw elsewhere. By allowing us to handle, process, and collect the raw data using computer code, it ensured we better understood what the instruments were measuring, how they were doing so, and what the mathematical equations we used actually meant.

For all of these reasons, I think Dr. Le is the ideal candidate for this award. I hope this letter gives some insight into her masterful pedagogy and her innovative approaches in the lab.

Sincerely,
Brady Sanders

Subject: Support for Dr. Anh Le's CTL Lab Instruction Award Nomination

January 23, 2024

Dear Committee,

I'm writing to enthusiastically support the nomination of Dr. Le for the CTL Innovation and Excellence in Laboratory Instruction Award. As both a previous student and a current Graduate Teaching Assistant for the Physical Chemistry lab, I've had the pleasure of seeing Dr. Le's dedication to making the lab experience educational and enjoyable for students.

Dr. Le has a unique ability of connecting with students and making challenging material enjoyable. She's passionate about teaching and committed to creating a lively learning environment in the lab. Dr. Le's approach to lab instruction goes beyond the usual science labs, including various experiential learning opportunities that involve students in investigation, analysis, and application.

Having been a student in Dr. Le's PChem lab last year, I can vouch for the positive impact it had on my understanding of course concepts. The hands-on experience she provides not only deepened my understanding of complex scientific principles but also fostered a genuine appreciation for the subject.

Now as a GTA for the same course, I've witnessed Dr. Le's unwavering commitment to student success. She creates a supportive and inclusive learning environment, sparking curiosity and enthusiasm among students. Dr. Le goes the extra mile to ensure students not only grasp theoretical concepts but also develop practical laboratory skills for their academic and professional journeys.

I strongly believe that Dr. Le is exceptionally deserving of the CTL Innovation and Excellence in Laboratory Instruction Award. Her dedication to enhancing the educational experience through innovative and experiential learning sets a standard that inspires both students and colleagues.

If you need more information or want to discuss Dr. Le's qualifications further, feel free to contact me. I'm honored to provide this letter of support and enthusiastically recommend Dr. Le for this well-deserved award.

Sincerely,

Jenna RisCassi
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Angel Vasquez
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Dear reviewers:

I have had the great privilege of being in Dr. Anh Le's physical chemistry laboratory last year in the spring as a student, and this semester as an undergraduate teaching assistant.

Dr. Le has designed this course to experimentally test and conceptually apply fundamental quantum mechanics, thermodynamics, and kinetics, as well as introductory computational chemistry. She has found a way to flawlessly integrate the usage of instrumentation that are not taught or used in other courses such as Differential Scanning Calorimetry (DSC), gas-phase infrared spectroscopy, utilization of Nobel Prize Winner Brus's Model for quantum dots analysis, and computational chemistry software. She also provides and encourages students to use Mathematica, a powerful analytical tool that is widely used to perform complex calculus and linear algebra operations. Mathematica calculations are weaved into the calculations automatically since some calculations are made easier through this application such as solving a matrix's eigenvalues and eigenvectors, thus proving the capability of the software to her students.

During the lectures outside of laboratory hours, Dr. Le provides sufficient background to refresh or teach students depending on their progress in physical chemistry courses. After reviewing core concepts, oftentimes the experiments she designs require using further concepts that are not touched upon in physical chemistry courses such as the equipartition theorem, Hartree-Fock theory, etc. Although it is new knowledge to the students, she provides deeper derivations and theories to Georgia Tech students that are readily open to digesting difficult concepts. This is her voluntary commitment and contribution to producing stronger students to maintain the prestige of the chemical studies at the institution. Apart from teaching scientific knowledge, Dr. Le always makes it obvious how the content for that week's lab is related to real-world applications. This ensures that the experiments are up-to-date with modern technological advances. In the case that students are still struggling with concepts, she makes herself very accessible for people to stop by her office and ask any questions. There is no day that Dr. Le is not happy to interact and address the questions/concerns of her students.

From a teaching assistant perspective, it is eye-opening to see her dedication to the course outside of laboratory and lecture hours. To assure that the students receive accurate and insightful information during lab periods, she goes over the experiment with teaching assistants, addresses any safety concerns, and explains any common mistakes or issues that students commonly face during experiments and analysis so that teaching assistants are aware to address those things during the lab period. Also, she is constantly innovating experiments such as replacing a heat of reactions experiment with bomb calorimetry and designing a new end-of-semester project that will allow students to create their own spectroscopic instruments and explore how certain components are vital to recording and interpreting data such as tuning the signal-to-noise ratio. Innovation is what keeps the course fresh and relevant at the same time.

For these reasons and others, I can give you my wholehearted recommendation for Dr. Le. Please reach out if there is any further information or support I can provide. Thank you for your consideration.

Best regards,

Angel Vasquez