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Stephanie Chasteen
TRESTLE
University of Colorado

Dear Stephanie,

It is my pleasure to write in support of the proposal by Cheryl Pinzone, Nichole Barger, and Jennifer Knight, entitled “*Transforming pedagogy and science education courses for graduate student teaching assistants—integrating models of graduate training*”. These three investigators will make a powerful team committed to developing training for graduate student Teaching Assistants.

The project proposes to transform two different graduate courses that have been taught in EBIO and crosslisted with other departments. The first, *Pedagogy for Future Faculty*, was developed by the Lead GTAs in three departments and supervised by a faculty member (myself for 2 years and others in other years). This course was impressive in being developed by graduate student teachers, but it would also benefit from the proposed activities described in this proposal. The second, *Science Education Teaching and Learning*, was developed by Nichole Barger and Jennifer Knight and has been a great resource for graduate student teachers.

The proposed project will use surveys of graduate students and faculty to inform development of these courses. This information will then be incorporated into the development of revisions for these courses. Cheryl Pinzone will take the lead on the *Pedagogy for Future Faculty*, which would benefit from her expertise and experience. Nichole Barger and Jennifer Knight, in collaboration with Cheryl Pinzone, will work to transform the *Science Education Teaching and Learning* seminar.

This is a strong team and the proposed transformation of these two important graduate courses will be of great benefit to both our graduate students and the undergraduates that they teach!

Sincerely,

M. Deane Bowers
Professor and Chair, Ecology and Evolutionary Biology
Curator of Entomology

Project title and PI

Transforming pedagogy and science education seminar courses for graduate student teaching assistants - integrating models of graduate training

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Project leader and expertise

Prior experience in course transformation.

Pinzone has made a significant investments into professional development around course transformation, evidence-based pedagogical approaches, and improving teaching and learning. She transformed a section of General Biology (EBIO 1210) in the School of Continuing Education, in a flipped-hybrid format with an active-learning approach. She recorded and captioned video lectures, created activities such that the majority of class-time is devoted to active-learning (COPUS observation data: <http://bit.ly/2CcFGm9>), and developed pre- and post- assignments for each module with incorporated reflection activities. These efforts were supported in part by Arts & Sciences Support of Education Through Technology (ASSETT) Flipped Classroom Workshop, involvement as a TRESTLE Scholar for two semesters in designing group-worthy activities and metacognition, and award of a Universal Design Fellowship from the Office of Information Technology to create accessible and inclusive course materials. Although student reviews are only one piece of evaluation, student feedback has been overwhelmingly positive and enrollment has increased (Armando Pares, Assistant Dean of Continuing Education, armando.pares@colorado.edu, personal comm.). Pinzone supports faculty in course transformation efforts for several courses as a Science Teaching and Learning Fellow in the EBIO department, and regularly engages in professional development and collaborative learning communities around teaching and learning.

Barger has dramatically changed her approach to teaching in order to enhance student learning based on decades of teaching experiences, interactions and feedback from students, and involvement with discipline based education experts on campus and teaching workshops. She has restructured her courses to align with our current understanding of how students learn, using a student-centered *evidence-based approach*. This approach is an adaptive style of teaching in which the use of research-based best teaching practices, which are centered on the learning needs of the student, is coupled with assessment of student learning gains and experiences. Barger developed a graduate seminar in science education for graduate students interested in science education careers, and collaborated with graduate students to design a model for graduate student training in science education in which mentorship and support for teaching is provided to graduate students at varying stages of their career. For four years, she coordinated a teaching program within the EBIO department to mentor two graduate students every fall semester in teaching their own course. During the semester, she would schedule mentoring meetings and conduct classroom observations and student interviews to provide feedback to the graduate student instructors in their teaching. She plans to continue this mentoring program with our summer instructors, many whom are graduate students, instructors, and post-doctoral research associates.

Knight was the MCDB Coordinator for the Science Education Initiative for 7 years. During that time, she helped develop three nationally-used concept assessments, transformed introductory biology courses, trained several postdoctoral fellows, and worked extensively with faculty members from multiple departments. She also directed the faculty development HHMI Mountain West Regional Summer Institute on Undergraduate Education in Biology for 5 years, and was a workshop leader for the NSF-funded postdoc teacher training program FIRST-IV. She has also worked with graduate students and postdocs in MCDB, Biochemistry, EBIO and IPHY in a science pedagogy course for the past 10 years.

Proposed work will further their learning.

Engaging in the proposed work will enhance the pedagogical, mentoring, and professional expertise of the project leadership. This work will result in the collection of evidence concerning Graduate Teaching Assistant (GTA) teaching professional development, and will provide educational research outcomes applicable to other training programs.

Supervision of personnel.

Graduate students will be integral to the development and implementation of this project. PIs will regularly discuss and incorporate graduate student feedback into course development, and will mentor and direct efforts from motivated graduate students, such as the lead students from the Graduate Teacher Program (GTP; Graduate School program) in EBIO and other departments, as well as all those engaged in Discipline Based Education Research (DBER). Additionally we would like to incorporate undergraduate student feedback as well, primarily from experienced Learning Assistants (LAs), and have them present about and discuss their experiences.

Fulfillment of commitments made in this proposal.

This proposal will have been distributed among the EBIO curriculum committee, departmental leadership, and other engaged faculty and graduate students within and outside the department, to gain collective support, ideas, and accountability. Additionally, we plan to present widely and publish the results of this work, and are pursuing additional resources and commitments in order to achieve the goals laid out in this proposal (explained in detail in Other resources leveraged).

Compelling project rationale

How will this course transformation contribute to the teaching and learning needs in your unit or in your college?

There are many benefits for graduate students to receive training in best practices in teaching and learning, and placing highly trained graduate student instructors in the classroom will inevitably improve the quality of undergraduate education. Graduate students in STEM disciplines at the University of Colorado Boulder (UCB) contribute towards substantial student contact hours, serving as graduate teaching assistants in lab courses, recitations, and lecture courses, or are given the opportunity to become an instructor of record. Instruction in many college STEM courses is being transformed through the adoption of student-centered, evidence-based teaching practices. Although many faculty are being provided support for development in this area, graduate teaching assistants (GTAs) often do not receive the same opportunities for training.

Transformation of courses which help train GTAs will support the rapidly changing teaching and learning needs we are faced with. The two courses we would like to transform are cross-listed in four different departments and have contributed to the training of GTAs from at least six different departments. Previous efforts have identified the benefits and barriers to increasing training, and developed a model to enhance graduate training opportunities in STEM education (Love Stowell et al. 2015). Additionally, we would like build a community centered around pedagogy and integrate other models of training graduate students in teaching and learning. These efforts will build from and compliment the graduate teaching opportunities currently provided to STEM graduate students at UCB.

We would build on prior knowledge garnered from the Science Education Initiative (SEI). For example, SEI efforts in the department of Chemistry and Biochemistry at UCB, tested an interactive model which integrates learning theory within the context of content, which increased GTAs ability to lead student-centered recitations and develop professionally (Pentecost et al. 2012). Therefore, an integrated approach appears to best support training for improved understanding in implementing pedagogical practice into discipline (Gallardo-Williams and Petrovich 2017; Langdon and Pentecost, personal comm.).

Additionally, a training program model developed and refined in the SEI at UBC for a graduate course in science learning and teaching will be integrated, to include aspects of educational and cognitive psychology such that STEM graduate students may apply these principles in their home departments. This model has students choose a target course for development, presumably one they are or will be teaching in the future, and throughout the course they focus on topics in teaching and learning (e.g., cognitive load, prior knowledge, expert/novice knowledge organization, learning goals, motivation, transfer, metacognition, formative assessment, peer instruction, etc.) and engage in assignments, activities, and reflections in order to learn how to apply the concepts and evidence from educational research into their discipline.

While a diversity of TA training approaches have been utilized by a number of disciplines within even just one institution, there appears to be essential elements which contribute overall to program success (CTL, Stanford. 2008). Effective training programs often share the following: making teaching expectations explicit, developing narratives consistent with the departmental climate of support for teaching, designing programs with the input of experienced GTAs, and incorporating opportunities for GTAs to be mentored by faculty or peers. We aim to utilize this knowledge in course development and transformation.

Realistic and specific course development plan

A. Courses: *What courses will be changed, and what are the changes being contemplated?*

We are proposing to transform two graduate level courses, The Pedagogy for Future Faculty Seminar (EBIO 5460/ENVS 5100/GEOG 5100) and the Science Education Teaching and Learning Seminar (EBIO 6100/MCDB 5650). Each are aimed at strengthening graduate student teacher training, the Science Education seminar (Course 1) is offered in Fall and the Pedagogy seminar (Course 2) is offered in Spring.

We build from a graduated model of pedagogical training in which mentorship and support for teaching is provided to graduate students at varying stages of their career. GTAs would progress from learning pedagogical techniques and gaining classroom management experiences with Student Teaching Units. However a select few students advanced to lead instructor roles and acquired course development and lesson planning skills, the majority of GTAs only have limited time and opportunities to engage in teaching and pedagogy training.

Here, we will develop units that integrate teaching and learning theory within Biology and Environmental content and contexts, and harness the inter-disciplinarity among students to facilitate innovations in an active-learning environment, thus temporarily removing students from their ‘silos’ to find common ground with which to solve more difficult challenges. We will simultaneously take into account faculty and GTA training needs, establish a Biological & Environmental GTA community, and engage in deliberate practices with observation and course reflection opportunities.

Table 1. Proposed timeline of project activities.

March 2018	Develop and distribute a survey for GTAs to identify their needs and current gaps in teaching and professional development training.
April 2018	Develop and distribute a survey for faculty to outline their needs from GTAs, their expectations of GTAs, and what skills should be trained
Summer 2018	Target courses in EBIO and MCDB to outline expectations for GTAs, PIs meet regularly for course development, build community resources
Fall 2018	Course 1 - establish community, have GTAs from other departments discuss expectations with their faculty, identify what skills they want to learn
Spring '19	Course 2 - maintain community, continue to scaffold pedagogy training

B. Timeline: *What is the approximate timeline for making these course changes? What are the staffing plans for those courses (who will be teaching the course, and when?)*

Table 1 above, outlines the timeline for project activities. The PIs will work on survey and course development March-Summer. The Fall 2018 Science Education seminar will be co-taught by Nichole Barger and Jennifer Knight, and the Spring 2019 Pedagogy course would be led by Cheryl Pinzone, potentially with motivated graduate students as done in the past, and/or postdoctoral scholars in DBER.

C. Assessment Plan: *How will you assess whether the course changes have the impact you desire on student learning, retention, engagement, etc.?*

Undergraduate student outcomes are greatly influenced by the knowledge and skills of GTAs. We are interested in assessing whether undergraduate students taught by GTAs trained in these courses demonstrate improved knowledge and skills or demonstrate greater interest in learning biology. To this end, we plan to survey undergraduate students taught by GTAs enrolled in these courses and those taught by GTAs not involved in training, using the Test of Scientific Literacy Skills, appropriate disciplinary concept assessments, and Colorado Learning Attitudes about Science Survey. There are also measurable characteristics of GTAs that can be used to evaluate the effectiveness of training related to GTA cognition such as Pedagogy of Science Teaching Tests and Science Teaching Efficacy Belief Instrument, as well as related to GTA teaching practices such as Classroom Observation Protocol for Undergraduate STEM, end of semester evaluations, and Science Teaching Efficacy Belief Instrument. This framework for evaluation and research may allow for coordination research across institutions at a national level (these instruments and overall conceptual framework are outlined in Reeves et al. 2016).

D. Faculty & Instructor Involvement: *How will other faculty/instructors be involved in this work, and to what extent? How will that faculty effort be recognized or rewarded?*

We will incorporate faculty and instructor feedback in all aspects of the project. We have already included the department curriculum committee (tenure-track faculty and non-tenure track instructors) and hope to continually get their feedback throughout the process. We would announce the project at EBIO and MCDB faculty meetings, Faculty Learning Communities focused on pedagogy, and DBER. We will broadly survey faculty about their opinions on how GTAs should be trained and what skills they should have (within and outside the department), and persuade faculty with store-bought baked goods to fill out our survey (independently purchased). Finally, we hope to partner with curricular mapping to get course specific GTA needs and expectations, within the department faculty are incentivized internally, and then once a framework has been built, we will ask GTAs enrolled in the course to have discussions with faculty they are or anticipate teaching with, to establish clear expectations and focus their learning.

E. Sustainability: *How will changes in this course be sustained, especially if new instructors will be teaching it in the future? Be specific about these plans, as this is a common failure-point for course transformation efforts.*

Courses training graduate students in innovative teaching practices have been continued for the several years, and if this course transformation is funded, will provide information to refine and improve the existing model. Broadly, it is our hope that discussing these efforts and outcomes with faculty in and outside the department and their continued interactions with pedagogically-trained GTAs will widely disseminate evidence-based practices, and may facilitate future pedagogical innovation adoptions.

Specifically, PI Pinzone will contribute to community-building, maintaining the pedagogical flow of information, and oversee the development of the materials such that they are available as collaborative online resources. This way, efforts may be passed on and improved by any future instructor or engaged person. Historically, these courses have had instructors from multiple departments (EBIO, MCDB, ENVS) as well as leadership from graduate students. Therefore, the facilitation of information sharing will support coordination among faculty and future student contributors. Additionally, Pinzone will maintain and store data collected as a result of this work.

F. Coordination across the department: *How do changes in this course relate to the curriculum as a whole? Are there ways that this effort will be coordinated with other courses or instructors?*

As mentioned above in section D, we aim to continuously elicit feedback from the curriculum committee (for which PI Barger is chair) as well as integrate these efforts with departmental curricular mapping. PI Pinzone will participate in a TRESTLE Scholars group on curriculum alignment in Fall 2018, and plans to be involved in departmental efforts in Summer 2018. Additionally, this proposal has been shared with the EBIO department Chair of Graduate Studies, Bill Bowman and includes a letter from the EBIO department Chair, Deane Bowers supporting the work.

Impacts on other faculty or departments

How will this work further the TRESTLE goal of spreading the use of evidence-based teaching practices in STEM departments?

This program will consist of partnerships between faculty and graduate students and will likely garner participation from a number of departments at UCB in the Biological and Environmental Sciences. Historically, these two courses have attracted enrollment from graduate students from EBIO, MCDB, Integrative Physiology (IPHY), Environmental Studies (ENVS), Geological Sciences (GEOL) and Geography (GEOG). Additionally, we plan to invite and include other departments, institutes, and units from within the College of Arts & Sciences.

By involving faculty in the process of identifying the expectations and skills desired for GTAs in their classes, and in turn providing GTAs training in evidence-based teaching practices, the GTAs themselves may be empowered to act as agents of change in their interactions with undergraduate students, and be more able to work with and communicate with faculty toward integrating pedagogical innovations. We believe this initiative is best framed from a disciplinary perspective rather than from the Graduate School GTP, as the greatest barrier identified in increasing training is the perception of faculty (and by extension graduate students) that time spent learning and practicing pedagogy will distract from research and prolong Ph.D. programs (Love Stowell et. al 2015). A Biological and Environmental Sciences focus can incorporate content without losing pedagogy than would a generalized program on teaching, thus integrating time and efforts of disciplinary training for GTAs and decreasing burdens on the faculty they teach with, while finding commonalities among disciplines with the lens of solving problems in teaching. Finally, some ideas and resources will be shared and bounced off of the Departmental Education Specialist network PI Pinzone is part of, and may help spread innovations more broadly.

Resources requested

1. Budget.

We request the maximum amount (\$10,000) in order to fund summer salaries to PIs for time and energy investment into course development and ongoing efforts into implementation.

2. Non-financial resources requested.

We would be very grateful for any opportunities to receive ongoing project feedback and ideas from individuals in the Center for STEM Learning.

3. Other resources leveraged.

PI Pinzone has applied to the BioTAP Scholars program which an NSF funded research coordination network incubator aimed at improving the teaching professional development provided to biology graduate students. Pinzone is a member of the Faculty Fellows program at ASSETT, and is developing a project as part of her participation in this 2-year program. A significant contribution could be utilizing the technological resources to build a website for these efforts, building and sustaining a newsletter/listserv method of distribution, and providing educational technology advice to the graduate teaching network and

multi-year community we build. We would also like to incorporate undergraduate perspectives using ASSETT's student-partner framework, as the undergraduate perspective is highly valuable in training and empowering graduate teaching assistants to be student-centered.

We hope to integrate this proposal into the larger curriculum mapping efforts underway in the EBIO department, providing a lens into teaching from the GTA perspective. These effort will be directed by Kendi Davies, Carol Wessman, Andrew Martin, and Brett Melbourne, and will be part of the regular activities of the curriculum committee chaired by PI Barger. Having multiple courses within the same curriculum coordinate and collaborate on graduate student teacher training would be a valuable contribution to the department teaching mission. This could serve as a model for other departments.

There are many opportunities to collaborate and utilize existing programs and resources, at UCB and beyond. The Graduate Teacher Program (GTP) is a division of the graduate school rather than a certain discipline, and may support in practical skills such as proposal and teaching material preparation. More broadly, the Center for the Integration of Research, Teaching, and Learning (CIRTL) enhances excellence in STEM undergraduate education through a national-level community of faculty (as well as postdocs and graduate students) committed to advancing evidence-based teaching practices for diverse learners, and they are engaged in a longitudinal study of future STEM scholars (LSFSS). Additionally, for the Biological sciences, Quantitative Undergraduate Biology Education and Synthesis (QUBES) project aims to improve undergraduate learning opportunities and better incorporate quantitative approaches in modern biology. There are Environmental Design and "Wicked Problems" which are very difficult to solve, and the challenge of teaching these concepts at a high level will require different disciplines to work together. Synthesis of these diverse approaches and collaborations may provide a robust and vigorous graduate pedagogy and professional development training, appropriate to the most pressing current needs and demands of our shifting landscape.

Agreement to expectations

The PI's agree to fulfill the expectations of successful applicants. We will, (1) sign a MOU, (2) submit an annual report and attend the annual TRESTLE gathering, (3) PI Pinzone will attend the October meeting at the University of Kansas, and (4) we will complete evaluation surveys and encourage faculty in the departments during faculty meetings and through listservs to fill out the evaluation surveys in conjunction with curricular alignment efforts.

(5) The efforts and results will be widely shared within and outside our departments. Pinzone already consults with several faculty in EBIO to aid in transforming their courses, the gained expertise from this proposal will strengthen her ability and skills to do so. Pinzone has been promised a slot in the EBIO brown-bag in the Fall, which mainly attracts graduate students, and will be a good forum for discussing this work and getting feedback. DBER will be an excellent venue to present the research results of this project, and will aid in the publication of these results. In addition, Pinzone would like to present this work at the Society for the Advancement of Biology Education Research (SABER). Finally, if Pinzone is accepted into the BioTAP Scholars program, she will present this work at the Association for Biology Laboratory Education (ABLE) conference in June.

References

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