# Leveraging the Cultural Practices of Science for Making Classroom Discourse Accessible to Emerging Bilingual Students

## Problem

In current elementary science classrooms, students who are learning English as a second language are often excluded from activities. The primary reason is because learning environments are predominantly designed to accommodate English as the sole language of communication and instruction. The trend is expected to worsen, as more of these students are expected to enter schools and the increasing scarcity of qualified teachers who can meet students' language needs (Kindler, 2002). While this group of students is regularly referred to as English Language Learners (ELLs), we will use the term *emerging bilingual* to highlight the range of resources they bring to the classroom (Escamilla and Hopewell, 2010).

Literature shows that there has been a significant decrease in the amount of classroom time devoted to science in elementary schools, partly because of pressures to increase emerging bilingual students' English fluency (e.g., McMurrer, 2008). And, as mentioned above, elementary school teachers struggle to create learning environments in which emerging bilinguals can engage and participate in science activities. We believe, on the contrary, that science is the perfect context for providing opportunities for students to use language as a tool for communicating, which promotes students' language development. A learning environment centered on scientific practices, which capitalizes on students' natural curiosity and desire to understand the world, then, can support emerging bilingual students to engage in discussions with peers about meaningful questions.

Despite valuable efforts to understand the role language plays when emerging bilingual students learn science (Rosebery, Ogonowski, DiSchino, Warren, 2010; Suárez and Otero, 2013; Suárez and Otero, in press; Warren, Ballenger, Ogonowski, Rosebery, Hudicourt-Barnes, 2001; Warren, Ogonowski, Pothier, 2005), it is still not yet clear how to increase the participation of emerging bilingual students in science classroom activities. This study, then, would explore the hypothesis that science, physics in particular, is especially well-suited for increasing the participation of emerging bilingual students in negotiating meaning and participating in class. The results from this study would contribute to the literature on science education, specifically with regards to designing learning environments that engage emerging bilingual students. Additionally, it would contribute to the literature on English language development, particularly in identifying effective learning environments that foster participation and discussion. And lastly, this work would have pedagogical implications for how elementary school teachers can make their science lessons more accessible and inclusive.

## Theoretical Background and Literature Review

Researchers have proposed Productive Disciplinary Engagement (Engle & Conant, 2002) as a construct for describing active student participation. Specifically, this type of engagement is defined as one in which students spontaneously participate, substantially contribute, and attend to each others' ideas in a way that resembles disciplinary discourse practices and furthers intellectual progress. While not proposed with emerging bilingual students in mind, this framework can help us understand the learning environment features that can increase these students' engagement and participation. Four measures have been suggested to evaluate if a learning environment can foster this type of engagement. First, teachers should encourage students to problematize the content through questions, proposals, and challenges. Second, it is important for "students to be authors and producers of knowledge … rather than mere consumers" (Engle & Conant, 2002; p. 404). Third, students should be held accountable, particularly by how their work is responsive to what community insiders and outsiders have established. Finally, it is necessary for students to have relevant intellectual and/or material resources to aide sense-making (Engle & Conant, 2002). While this is not the only framework that describes disciplinary engagement, we chose it because of how well the four principles align with disciplinary practice, especially authorship and accountability to the local and disciplinary communities. Based on these four principles, we propose that physics has a clear advantage over other subjects because experimentation typically involves the presence of tangible objects and shared observations. Moreover, scientific practices involve supporting and promoting student participation through reasoning, argumentation, and sharing ideas about observations of phenomena, all of which can be accessible to students with different levels of English fluency.

We see almost a one-to-one correspondence between the four principles proposed by Engle and Conant (2002) and what we would expect to find in a learning environment based on inductive reasoning. To make the connection apparent, here we define scientific induction. The process of scientific induction ideally consists of observing physical phenomena and collecting evidence, followed by testing and postulating generally applicable principles supported by the data. Subsequently, these evidence-based claims are presented to the scientific community and subjected to the peer review process. The community ultimately (though not usually directly) arrives at consensus regarding inclusion of these principles in the larger corpus of knowledge.

Classrooms that espouse the scientific inductive process almost effortlessly meet the criteria described above for productive disciplinary engagement and promote meaning-making during activities. In these learning environments students problematize content through their observations and are authors of the evidence-based claims; these abstractions of are submitted to, and evaluated by, other students in the community. This framing aligns with Vygotsky's theory of concept formation (Vygotsky, 1962), which proposes learners move between two types of spaces: informal spaces that are populated with everyday experiences and interactions with the physical world; and academic spaces that house formal knowledge made available and validated by disciplinary communities. During the process of concept formation learners develop conceptual understanding through grounding academic concepts in everyday experiences, while leveraging these particular instances for deriving generalizable, academic concepts (Otero and Nathan, 2008).

Even though structuring classroom science activities on principles of productive disciplinary engagement has great potential for increasing accessibility, it is important to consider what features of the learning environment are effective in supporting the inclusion and participation of emerging bilingual students. Some argue that what is needed is the creation of hybrid spaces (Gutierrez, Baquedano-López, Turner, 1997) where students can recruit everyday language and communication practices when sharing ideas associated with formal, academic terminology and classroom norms. These emergent *third spaces* integrate everyday space (counterscript) and academic space (official script), "creating the potential for authentic interaction and learning to occur" (Gutierrez *et al.*, p. 372). These third spaces allow for the trying out of new, academic terms through the negotiation of meaning by deploying one's own, everyday language and discourse practices. Gutierrez and her collaborators (1997) suggest that literacy development is related to students' deployment of everyday language in the service of testing of formal literacy practices. Through this bi-directional process, students construct and negotiate meaning.

We view learning as a social practice (Rogoff, 1994; Wenger, 1998) and assume that students' development of conceptual understanding and language skills is co-constructed through social interactions. Our position on language differs significantly from *second language acquisition* models, which propose that language is an external device that needs to be acquired by the learner, instead of a meditational tool that is socially and iteratively constructed through interactions. This perspective is based on the work by Razfar and colleagues (Razfar, Licón Khisty, Chval, 2010), who redefine "language as a mediational tool for learning rather than the object of learning and instruction" (p. 214). Razfar et al., (2010) prompt us to think about language development as concrete steps students take towards "the use of any word to signal an object in a decontextualized manner" (p. 201) and abstraction, which can only be achieved through situated undertsanding. This has significant implications for how teachers structure learning environments and activities for students to engage with. Particularly, the fundamental question for designing and organizing learning environments should be "how will students use language to reach the learning goals?", rather than "what language do we expect students to acquire?" Finally, this model positions students as capable of learners whose development depends on the participation on multiple types of learning activities.

We hypothesize that science is particularly suited for creating hybrid spaces that provide opportunities for emerging bilingual students to become the authors and evaluators of evidence-based claims generated by shared, tangible experiences, furthering conceptual understanding. This study would address the following general question: *what role do everyday and academic language play when emerging bilingual students engage in making sense of the physical world?* Specifically: (i) what features of a classroom based on scientific induction foster productive disciplinary engagement of emerging bilingual students? and (ii) how do third spaces, where everyday and academic language interact, affect students' meaning-making? Several data streams (e.g., classroom videos) would be collected from elementary school emerging bilingual students and teachers, and analyzed using qualitative and quantitative methodologies (see *Project Timeline*).

**Study Design and Procedure**

*Research Context and Participants*

To study how the interaction of every and academic language can promote productive disciplinary engagement of emerging bilingual students, I have selected a local school district with a large population of students who are learning English as a second language. Within this district, I have identified the elementary schools that serve a large number of emerging bilingual students (more than half of the student body come from non-English backgrounds), and have already established relationships with STEM coordinators in two of the schools. The coordinators are in agreement with the framework of the study, and offered their assistance in meeting and recruiting teachers to work with. One of the coordinators will be leading summer school programs in collaboration with other elementary school teachers from the district, to which I was invited to participate as a way to meet and recruit teachers from the schools I have selected.

Based on the topic of study I have decided on selection criteria for enlisting teachers and students. With regards to teachers, the most important requirement is that they are willing to enter a collaborative relationship with me for co-planning and co-teaching science lessons, with the possibility of meeting at least once a week for planning and reflecting on activities. A corollary of this requirement is interested teachers would be willing to modify science units to fit the model described below (see *Implementation Design*). In addition to the first requirement, they would need to teach any of the grades 1-5 and, as mentioned above, at least 50% of their students would need to be classified as emerging bilinguals. Ideally I will be able recruit two to three teachers from the same school, which would make comparison between classrooms easier given that they would all be embedded in a similar context. There will be no specific requirements for students to participate in this study, other than being in a classroom where a majority of students are learning English as a second language, and sign appropriate consent forms agreeing to participate in the study.

*Implementation Design*

This study relies on the framework of Productive Disciplinary Engagement for designing curricular units and activities, as well as exploring what features of the learning environment may support emerging bilingual students engaging in classroom science discourse. Any activity created or revised for the purpose of this study would have to meet the four productive disciplinary engagement principles from Engle and Conant (2002): (i) provide opportunities for students to problematize content and observed phenomenon; (ii) create spaces for students to author ideas; (iii) foster a culture of accountability to the local classroom community; and (iv) make available material and symbolic resources for students to use during making sense of phenomena. In other words, the resulting activities from the collaboration between teachers and I would have to have: meaningful questions, tangible objects students can interact with, and create opportunities for students to share experiences about phenomena; an environment in which students feel safe offering their thinking and where everyday and academic language interact is also important.

I anticipate a certain amount of variation across the different classrooms and teachers I work with. This difference will be due to the range in experiences and goals of the participating teachers, difference in grade levels, and the student composition of those classrooms. To account for this variance, I will create profiles for each classroom, detailing characteristics of the teachers, students, and context to better understand participation. Hopefully these profiles will allow for the direct comparison between classrooms, leading to generalizable conjectures about the features that contributed to productive disciplinary engagement.

Based on the goals and structure of the implementation, I expect to spend a few hours per week working with every teacher and grade level (see *Project Timeline*). The first meeting with each teacher would have the goal of selecting two to three science units from the curriculum we would be interesting in adapting, as well as deciding on a meeting schedule. After the first meeting, I expect to meet once a week with each teacher to design lessons and activities from the selected units, and do the activities ourselves. Simultaneously, I will attend every teacher's science lessons, at first to observe and become familiarized with the context, and later to co-teach the developed activities. Ideally I would meet with teachers shortly after activities are implemented, to reflect on how students' engagement was affected by an activity. Nevertheless, I am mindful of teachers' time constraints and responsibilities, and expect reflection sessions to be postponed for a while after implementing activities. It is important to remember that the focus of the study is to study the features of the learning environment that promote productive disciplinary engagement, rather than teachers themselves.

*Data Collection*

Due to the scope of this study, different types of data will be collected from different streams (see Table 1 for more details). One group of data will focus on capturing *interactions*, which is the appropriate unit of analysis given the sociocultural theories of teaching and learning that frame this study. Primarily I will try to capture the way members of the learning community (students and teachers) interact with each other, as well as with other mediational tools (e.g., tangible objects, language, worksheets). Another group of data will focus on the collaboration between the teachers and the researcher, and resulting planned activities. Finally, demographic and achievement data of the participating students will be collected, including reading level and English fluency as determined by the districts' assessments. The bulk of data collection would take place during the Fall 2014 semester, with a few events in early Spring 2015. Data would be collected at least twice per week per classroom: once during teacher-researcher planning meetings, and once during the implementation of the activity (see *Timeline* for more details).

<u>Classroom Video and Field Notes</u>

One primary data source will be video of classroom interactions, which would be collected every time students participate in a science activity. Through this type of data I hope to capture the frequency and nature of interactions between students and students, or students and teachers, any changes in participation experienced by community members throughout the implementation of activities, and the effect of structures (curricular or social) that regulate emerging bilingual students' engagement in science discourse. Additionally, my position as a *participant observer* in the classroom would give me a privileged position for understanding what design features of the learning environment seem to affect student engagement. Therefore, I will collect summaries and comments on students' productive disciplinary engagement.

<u>Student Work</u>

Understanding that different students may prefer to engage with the content in ways other than public discourse, it is important to look at other venues where students may feel more comfortable their thinking visible. Therefore, I will collect different types of student work produced during the activities (e.g., worksheets, written statements), and will do so every time a science activity is implemented. The goal is for all students to eventually feel confident and safe enough with sharing their ideas and productively engaging with science. But I am sensitive to the fact that not all students may reach that goal at the same time and through the same path, which is why collecting non-public externalizations of thinking can give us an alternative perspective on how students decide to voice their thinking. Moreover, this will give us a sense on whether the written materials created for supporting the activities have the intended consequences of promoting student engagement.

<u>Audio recordings of meetings with teachers</u>

To better understand the process of designing and implementing activities based on the principles of productive disciplinary engagement, I would need to record co-planning and reflection sessions with participating teachers. During co-planning meetings I expect the conversation to focus on how to adjust or create activities that foster productive disciplinary engagement, as well as meet curricular requirements. Analyzing these conversations will give me insight into how teachers think of engagement and what activity features they consider the most salient for promoting engagement. Additionally, the content of these conversations will serve as a record for what the original activity plan was, in case it is modified during implementation. Recording reflection meetings will also be important to determine what decisions were made while implementing an activity, and how they served engagement. Lastly, these debriefing meetings will focus on how the researcher and teachers think students partook in the planned activities, in an effort to understand student thinking and how activities could be modified to be even more effective for specific groups of students.

Table 1: summary of data collection efforts and potential outcomes

| Construct | Data Sources | Outcome |
|---|---|---|
| Productive Disciplinary Engagement | Classroom Video and Field Notes | Understand what features of learning environments support students to engage in science activities and discussion |
| Interaction between everyday and academic language | | Understand how everyday and academic language foster or hinder student participation in classroom discourse |
| Productive Disciplinary Engagement | Student Work | Understand how students may be engaging with science activities through written work and/or diagrams |
| Interaction between everyday and academic language | | Understand how everyday and academic language interact in written work and/or diagrams |
| Productive Disciplinary Engagement | Audio recordings of meetings with teachers | Understand how teachers design learning environments that can foster engagement |
| Interaction between everyday and academic language | | Understand how teachers navigate and leverage the interaction of everyday and academic language |

*Data Analysis*

I will rely on several strategies for analyzing the data collected from the different streams. The first step will be to unpack the data by developing a coding scheme for categorizing interactions. Classroom videos will transcribed and coded according to the four principles for productive disciplinary engagement proposed by Engle and Conant (2002): (1) *problematizing observed phenomenon*, (2) *display of authorship of ideas*, (3) *accountability to their local community*, and (4) *use of material resources*. Data coded as *problematizing observed phenomena* may attend to mechanistic reasoning (Russ, Scherr, Hammer, Mikeska, 2008), and will be further investigated in terms of how, and for what purposes, students use everyday and formal language in the service of constructing explanations. Audio recordings of meetings with teachers will initially be coded according to the same principles from productive disciplinary engagement, only that I will be looking for instances in which teachers refer to opportunities for either of the four tenets to take place (e.g., opportunities for students to problematize phenomena). I anticipate that not all these *a priori* codes will capture all the patterns that emerge during interactions, which is why I will also rely on an emergent coding approach to supplement the initial coding framework. Emergent or inductive coding will be particularly helpful for identifying patterns in how everyday and formal language interact for promoting or hindering students' productive disciplinary engagement.

In addition to coding the transcribed classroom videos and meetings with teachers, I will rely on triangulating patterns that emerge from the transcript with other data collected from other streams (e.g., student work). Triangulation will be crucial for confirming the persistence of patterns in engagement and language use, strengthening the validity of claims. Finally, in order to bring coded and triangulated data together, I will use reconstructive analysis to create a narrative of what I observed throughout my visits and how it all fit within the context of the school. This process consists of reconstructing the possible meanings "that other people in the setting might themselves infer, either overtly or tacitly" (Carspecken, 1996, p. 95), also known as meaning fields, which are implicit in the data that has been collected.

**Impact**

Being awarded the Chancellor's Graduate Award for Excellence in STEM Education would incredibly benefit my professional development. First and foremost, becoming an awardee would highlight the need for more research on how to make science education accessible to emerging bilingual students, as well as showcase my contribution to this effort. Moreover, becoming part of the prestigious community of graduate and faculty who receive the award would give me access to scholars who could help me improve my work through discussing it. Finally, the prospective financial support from the award to give me the opportunity to dedicate 25% of my time to the question I am most passionate about and motivated me to purse a doctoral degree in the first place: how to improve access and equity of science education for emerging bilingual students in elementary schools?

Simultaneously, the intellectual and financial support of this study will benefit the School of Education (SoE) and its commitment to providing equitable access to education. Within the SoE community there is consensus that science is one of the subjects in which students from underserved communities continue to receive poor quality instruction. And while there have been significant efforts to improve quality of instruction for minority students, most of these efforts have focused on high schools and undergraduate students. Therefore, my work will focus on an area of education that has not received as much attention, but is in great need. Moreover, the explicit focus on emerging bilingual students is a great opportunity for establishing academic relationships between scholars from the science education and language development fields. Strengthening intra-departmental relations will continue to foster the high quality, interdisciplinary work the CU School of Education is known for.

Lastly, The CU community has earned national recognition for its innovative and effective STEM education programs. Nevertheless, it is my opinion that there have been fewer efforts to understand how to improve access and equity STEM education. Therefore, supporting studies that address this question head-on will showcase the importance of considering how large groups of students are pushed out of STEM-field careers. Furthermore, I believe an explicit focus on elementary school science education will highlight a period of students' education that has been typically neglected by disciplinarians who engage in discipline-based education research. I believe, then, that committing intellectual and monetary support to this study will send the message to the CU STEM community that elementary school science education is in great need of supporting, especially considering this is a time in students' education where it is easy to develop productive dispositions towards doing and learning science.

## Timeline

| | ***Summer 2014*** | | | ***Fall 2014*** | | | ***Spring 2015*** | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Meetings* | *Data Collection* | *Data Analysis* | *Meetings* | *Data Collection* | *Data Analysis* | *Meetings* | *Data Collection (until 02/15)* | *Data Analysis (starting 02/15)* |
| *Teachers* | Teacher Recruitment (summer school) | | | Weekly Planning | Audio recording of teacher meetings | N/A | Weekly Planning | Audio recording of teacher meetings | Data coding Triangulation Reconstruction |
| | | | | Weekly Reflection | Audio recording of teacher meetings | N/A | Weekly Reflection | Audio recording of teacher meetings | Data coding Triangulation Reconstruction |
| *Students* | | | | Weekly Implementation | Classroom Video | N/A | Weekly Implementation | Classroom Video | Data coding Triangulation Reconstruction |
| | | | | Weekly Implementation | Student Work | N/A | Weekly Implementation | Student Work | Data coding Triangulation Reconstruction |
| *Context* | | | | Classroom Norms | Classroom Video and Audio recording of teacher meetings | N/A | Classroom Norms | Classroom Video and Audio recording of teacher meetings | Data coding Triangulation Reconstruction |
| | | | | Student information | Demographics and School achievement information | N/A | Student information | Demographics and School achievement information | Data coding Triangulation Reconstruction |

## References


Carspecken, P. (1996). Stage Two: Preliminary Reconstructive Analysis. *Critical Ethnography In Educational Research* (pp. 93–120). New York and London: Routledge, Publisher.

Committee on Conceptual Framework for the New K-12 Science Education Standards, N. (2012). *A Framework for K-12 Science Education: Practices, Croscutting Concepts, and Core Ideas* (p. 320). Washington, DC

Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction*, *20*(4), 399-483.

Escamilla, K. & Hopewell, S. (2010). Transitions to biliteracy: Creating positive trajectories for emerging bilinguals in the United States. In J. Petrovic (ed.). *International Perspectives on Bilingual Education: Policy, Practice and Controversy,* Information Age Publishing, 69-94.

Gutierrez, K. D., Baquedano-López, P., and Turner, M. G. (1997). Putting Language Back into Language Arts: When the Radical Middle Meets the Third Space. *Language Arts*, *74*(5), 1997.

Kindler, 2002 A. L. Kindler. (2002). *U.S Dept of Ed. OELA*, Survey of the states' limited English proficient students and available educational programs and services: 2000–2001.

McMurrer, 2008 McMurrer, J. (2008). *Instructional Time in Elementary Schools: A Closer Look at Changes for Specific Subjects* (p. 8). Washington, DC.

Otero, V. K., & Nathan, M. J. (2008). Preservice elementary teachers' views of their students' prior knowledge of science. *Journal of Research in Science Teaching*, *45*(4), 497-523.

Rogoff, B. (1994). Developing understanding of the idea of communities of learners. *Mind, culture, and activity*, *1*(4), 209-229.

Rosebery, A. S., Ogonowski, M., DiSchino, M., & Warren, B. (2010). "The coat traps all your body heat": Heterogeneity as Fundamental to Learning. *the journal of the learning sciences*, *19*(3), 322-357.

Razfar, A., Licón Khisty, L., & Chval, K. (2011). Re-mediating second language acquisition: A sociocultural perspective for language development. *Mind, Culture, and Activity*, *18*(3), 195-215.

Russ, R. S., Scherr, R. E., Hammer, D., and Mikeska, J. (2008). Recognizing mechanistic reasoning in student scientific inquiry: A framework for discourse analysis developed from philosophy of science. *Science Education*, *92*(3), 499–525.

Suárez, E., & Otero, V. (2013) "Because it hibernates faster": 3rd grade English Language Learners making sense of sound. *Physics Education Research Conference Proceedings 2012*, 406-410

Suárez, E., & Otero, V. (in press). Physics as a Mechanism for Including ELLs in Classroom Discourse. *Physics Education Research Conference Proceedings 2013*

Vygotsky, L. *Thought and Language*, MIT Press, Cambridge, 1962.

Warren, B., Ballenger, C., Ogonowski, M., Rosebery, A. S., & Hudicourt Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sense making. *Journal of research in science teaching*, *38*(5), 529-552.

Warren, B., Ogonowski, M., and Pothier, S. (2005). "Everyday" and "Scientific": Rethinking Dichotomies in Modes of Thinking in Science Learning. In R. Nemirovsky, A. Rosebery, J. Solomon, and B. Warren (Eds.), *Everyday Matters in Science and Mathematics: Studies of Complex Classroom Events* (First., pp. 119–149). Mahwah, NJ: Lawerence Erlbaum Associates

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge university press.

**Enrique Suarez**
2989 Shady Hollow East
Boulder, CO 80304
(405) 642-8983
enrique.suarez@colorado.edu

**Education:**

- August 2012 – present: Doctoral student in Science Education at CU Boulder
- August 2010 – May 2012: MS in Science Education, Tufts University
- August 2008 – May 2010: Physics doctoral student at Carnegie Mellon University
- August 2006 – December 2007: BS in Astrophysics, University of Oklahoma
  Completed one year as exchange student in excellent standing; transferred to complete degree
- September 2000 – July 2006: Physics undergraduate at Universidad Simon Bolivar. Caracas, Venezuela
  Most courses were in mathematics and theoretical physics; transferred before completion

**Teaching Experience:**

- January – May 2013: Instructor for Step 1 course for CU Teach, CU Boulder
  Taught course for undergrad STEM majors who are interested in teaching science in K-12; coordinated with elementary school teachers to offer their classrooms for Step 1 students to practice teaching through inquiry; implemented inquiry based lessons; facilitated discussions about teaching and learning science through inquiry; supported students in designing, testing and enacting inquiry-based science activities in elementary schools grades 3-5; observed students when they implemented lessons and gave feedback; provided feedback on their written reflections on their implementation.
- September 2011 – June 2012: Science Specialist – Argenziano Community School, Somerville Public Schools
  Volunteered 10 hours per week, working with 1st, 2nd, and 3rd grade teachers from a Sheltered English program to develop and deliver science lessons; lessons were based on inquiry and argumentation, giving the students an opportunity to interact in a less regimented space that affords the development of self-agency and sense of self-efficacy, as well as English written and oral skills; included a research component that looked at resources teachers use when making sense of ELLs ideas and justifications, and how students use language for communicating their reasoning about mechanisms.
- September 2010 – May 2012: Teacher Assistant, Poincaré Institute for Math Education, Tufts University
  Assisted in creating the pedagogical and science content of online courses for Mathematics in-service teachers, grades 5-9; supervised, reviewed, and gave feedback on the work submitted by a group of six in-service teachers.
- June – August 2011: Tisch College Active Citizenship Summer (ACS) Fellow – Science Specialist in Summer Program from English Language Learners (SPELL), Somerville Public Schools
  Designed lessons, for intermediate and proficient English speakers, grades 1–5, around the topic of Light: selected readings appropriate for age and proficiency level, hands-on activities, and formative assessments (poems, drawings, reviews, etc.); created documents that summarized the importance of learning through inquiry and discussion (using the 'Science Talks' model) to be used in future years; held meetings with teachers to get feedback on lesson plans before implementing them, and finding ways to involve teachers in lessons; coordinated visits with local science-related organizations and institutions.
- August 2008 – May 2010: Teaching Assistant for Physics and Astronomy courses, Carnegie Mellon University
  Supervised and assisted students solving problems in groups; reviewed material, if necessary; taught 4 hours per week, additional to 4 hrs per week of office hours; graded homework, exams, and helped proctor; lectured when needed.
- Summer 2009, Summer 2010: Teaching Assistant for Physics, Summer Academy for Math and

Sciences (SAMS) for under-served students, Carnegie Mellon University
Taught 2 hours per week of recitation, assisting and supervising students in group work; reviewed material, if necessary; held 10 hours of office hours per week; graded homework, exams, and helped proctor; lectured when needed.

- August 2008 – March 2009: Mentor for the Department of Physics Outreach Program for Middle School Science Fair, Carnegie Mellon University
  Volunteered 3 hours per week helping a $7^{th}$ grade student understand the reasons behind blue and red skies; after trying to understand conceptually what produced these colors, we designed an experiment that would let us reproduce and measure this effect; coached the student when preparing a presentation about his topic, and on how to use the data he collected to make a compelling argument; the student won second place in a local science fair for Middle School students.

- January 2007 – December 2007: Cataloguer at the COMPADRE Digital Resources for Physics & Astronomy Education
  Proposed various websites to principal investigator for addition to the collection; accumulated information on approved websites, including description of the site, educational level, and citation information; expanded and updated the Astronomy section of the catalogue.

- January – December 2005: Physics Teaching Assistant, Universidad Simon Bolivar
  Supervise and assisted students solving problems in groups; reviewed material, if necessary; taught 4 hours per week, additional to 2 hrs per week of office hours; graded homework, exams, and helped proctor.

**Research Experience**

- May 2013 – present: Research Assistant, Physics and Everyday Thinking (PET) – High School, CU Boulder
  Co-developed a research plan, and data collection tools and strategies, to evaluate the implementation of the PET high school curriculum; collected and analyzed data, including videotapes of lessons and interviews with participating students, with the eventual goal of publishing results.

- May 2013 – present: Research Assistant, Noyce Teacher Teams, CU Boulder
  Co-developed a research plan, and data collection tools and strategies, to evaluate the progress of participating teachers and efficacy of the professional development program; supported a group of elementary school teachers in developing a research plan for understanding teaching and learning science in their $2^{nd}$ and $3^{rd}$ grade classrooms; collected and analyzed data, including videotapes of teacher meetings and surveys, with the eventual goal of publishing results.

- July 2012 – May 2013: Research Assistant, The New Movement in Physics Education Project, CU Boulder
  Review and catalogue articles from the late $19^{th}$ Century and early $20^{th}$ Century, regarding the state of Physics and Science Education Research. The primary focus is to understand the development of learning theories and pedagogical approaches that were most prevalent in Physics departments, Teachers Colleges, and science classrooms.

- September 2010 – June 2012: Research Assistant, Robert Noyce Teacher Scholarship Program, Tufts University
  Help develop courses in Physics and Mathematics for Mathematics and Science middle and high school pre-service teachers, who will work in urban and/or high need schools; help design a research plan, and data collection tools and strategies, to evaluate the progress of participating fellows and efficacy of the program; contacted universities, colleges, and national societies as part of the recruiting efforts to attract the most diverse and competent pool of applicants.

- September 2010 – June 2012: Research Assistant, Poincaré Institute for Math Education, Tufts University
  Co-developed a research plan, and data collection tools and strategies, to evaluate the progress of participating teachers and efficacy of the institute; collected and analyzed data, including videotaping and evaluating classes from a subset of participating teachers, with the eventual goal of publishing results.

- July 2011: Energy Project Summer Research Institute (EPSRI) Scholar, Seattle Pacific University
  Collected and analyzed data, including videotaping and taking field notes from professional development sessions, photographing work produced by participating elementary science teachers, and identifying episodes within sessions that could lead to further in-depth research; presented analyzed data during EPSRI conference.
- August 2008 – August 2010: Research Assistant, Carnegie Mellon University
  Advisor: Dr. Jeffrey Peterson.
  This project complemented proposed optical and radio astronomy surveys for studying the expansion history of the Universe, through the measurement of the Baryon Acoustic Oscillation. The feasibility of a galaxy survey based on Lyman $\alpha$ emission (UV) was the primary focus.
- Summer 2005, Spring 2008: Internship at Jodrell Bank Observatory. Manchester, England
  Studied Abell (ACO) Galaxy Clusters and searched for the amount of Neutral Hydrogen (HI) in them; produced a database that compiled information from every galaxy of interest; wrote FORTRAN codes that would analyze the data for each cluster to obtain properties like total mass of hydrogen in a cluster, virial radius and possible mass of dark matter in the cluster.
- January – December 2007: Senior Research Thesis, University of Oklahoma
  Advisors: Dr. Yun Wang and Dr. William Romanishin.
  This project studied galactic properties, specifically Balmer $\alpha$ emission, to determine better selection criteria for future galaxy surveys and measurement of the Baryon Acoustic Oscillation.

**Workshops:**

- June 2005: Observational Astronomy Instrumentation and Techniques Workshop at the Center of Astronomical Research (CIDA). Merida, Venezuela
- November 2004: Dynamic Astronomy in Latin America (ADELA) at the Center of Astronomical Research (CIDA). Merida, Venezuela
  The University Group of Astronomical Research (GUIA) of Universidad Simon Bolivar presented a poster that stated the benefits of building a radio observatory in Venezuela, increasing astronomy research and outreach

**Refereed Conference Proceedings:**

Suarez, E., & Otero, V. (accepted). Leveraging the Cultural Practices of Science for Making Classroom Discourse Accessible to Emerging Bilingual Students. *2014 International Conference of the Learning Sciences.*

Suarez, E., & Otero, V. (in press). Physics as a Mechanism for Including ELLs in Classroom Discourse, *2013 Physics Education Research Conference Proceedings*. Mellville, NY : AIP Press.

Suarez, E., & Otero, V. (2013). 3rd Grade English Language Learners Making Sense of Sound, *2012 Physics Education Research Conference Proceedings*. Mellville, NY : AIP Press.

**Conference Proceedings:**

Peterson, J. B., & Suarez, E. (2012). Intensity Mapping with 21-cm and Lyman Alpha Lines. *Proceedings of 47th Recontres des Moriond: Cosmology Session*. arXiv: 1206.0143 [astro-ph.CO]

**References:**

- David Hammer, Professor of Education at Tufts University Medford, MA david.hammer@tufts.edu
- George Klein, Associate Teaching Professor of the Physics Department at Carnegie Mellon University Pittsburgh, PA, klein@andrew.cmu.edu
- Bruce Mason, Principal Investigator of the COMPADRE library and Associate Professor at University of Oklahoma Norman, OK, bmason@nhn.ou.edu
- Valerie Otero, Associate Professor of Science Education at CU Boulder Boulder, CO, Valerie.Otero@Colorado.EDU

**Awards and Memberships:**

- August 2012 – May 2013: School of Education PhD Scholarship
- June 2011: Tisch Active Citizenship Fellow
- August 2008 – May 2009: Achievement Rewards for College Scientists (ARCS) Scholar
- October 2007 – Present: Golden Key International Honour Society
- Fall 2006 – Fall 2007: Dean's List at the University of Oklahoma
- Fall 2006 – Fall 2007: President's List at the University of Oklahoma

**Additional Skills:**

- Proficient in Windows XP, Macintosh OS 9 and 10, Linux (Fedora Core 4 and Redhat 9), Fortran, Interface Description Language (IDL), Microsoft Office Suite
- Intermediate skills in video editing software and transcription software, like iMovie, Final Cut Pro, and InqScribe.
- Fluent in Spanish, proficient in French, German, basic understanding of Italian and Portuguese
- Over 20 hours of clinical interviews with participants from different ages, mostly pre- and in-service teachers.
- Over 30 hours of videotaping and observing science and mathematics lessons from pre- and in-service teachers.