Title

Growing STEMs of the Buried Seeds: Developing STEM Identities of Mexican American Girls Across Time and Space

Author

Liu, David Da Wei

Publication Date

2019

UNIVERSITY OF CALIFORNIA,
IRVINE

Growing STEMs of the Buried Seeds:
Developing STEM Identities of Mexican American Girls Across Time and Space

DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

in Education

by

David Da Wei Liu

Dissertation Committee:
Associate Professor Hosun Kang, Chair
Professor Angela Calabrese Barton
Associate Professor Rossella Santagata
Professor Sandra Simpkins

DEDICATION

This dissertation is dedicated to those who
are working with communities to transform inequitable systems and
need a gentle reminder that there is still hope.

Remember, as the Mexican *dichos* goes,
"*Quisieron enterrarnos, pero no sabían que éramos semilla*
(They tried to bury us, but they didn't know we were seeds)."

This is dedicated to you.
It might seem like you are being buried now.
But you are one of many seeds.
And together, we will grow hope.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

I would like to acknowledge the case study girls and their families for providing this opportunity to learn with them. I know that you all have bright futures ahead of you and you will make your family and I proud. From our conversations about all the amazing food, YouTube videos, and memes, I am always reminded that learning with friends makes it worthwhile.

I would like to acknowledge the Camino Brillantes Academy (CBA) community, educators, teacher and staff for their support and partnership. In particular, I would like to thank the Executive Director, Curriculum Specialist (who was our main liaison), the 5th grade teachers, the Extended Day Coordinators, the front office managers, Ms. Perez for offering her classroom to us, and Ms. Paloma for being in the classroom with us at every moment. The educators and staff are the unsung leaders of this project. They have graciously welcomed me, encouraged me, and trusted me. I have learned so much with them. They have shown me that together we are more.

First and foremost, I would like to acknowledge my greatest advocate, teacher, and mentor: Dr. Hosun Kang. As a fearless and powerful leader, you have given me so much to help me grow as a researcher and a human being. You have guided me every step of the way and I am proud to be your student. I will always remember the pivotal moment of my trajectory as a scholar when you asked me what I was going to do instead of writing sad stories about girls not liking science. Back then, little did I know that your encouragement would bring me this far. I thank you.

I thank Dr. Angela Calabrese Barton for being for the feedback you have given me in person and for being such an inspiring role model. Every time I read your work, I am taken back and remember why I engage in this work. I thank Dr. Rossella Santagata for challenging me theoretically and methodologically. Your guidance in video research and social cultural perspectives on learning have been invaluable. I also thank you for welcoming to Project CRYSTAL where my entire research focus started. I thank Dr. Sandra Simpkins for shaping me into an afterschool researcher and guiding my thinking and writing as a scholar. My conceptual framework would not have emerged without your support in the writing class.

I would like to acknowledge my intellectual community for supporting my ideas and thoughts, being at the forefront of STEM education reform, and guiding me through this process. In particular, I would like to thank the following individuals for their feedback throughout this process. I would like to thank Dr. Edna Tan for meeting with me all the way in Canada at AERA to discuss my findings and helping me clarify my thoughts and ideas. I would like to thank Dr. Doron Zinger, my counterpart in the graduate program, for firstly recommending Camino Brillantes Academy as a research site. In addition, he has always provided encouragement and support during our group meetings, qualitative classes, and qualitative research meetings. Other researchers include Dr. Jennifer Long for her support in applying for grant funding and Dr. Tara O'Neill for feedback on my initial dissertation study.

I would like to acknowledge my parents who always believe in me, love me, and are proud of me. I want them to always know that I am grateful for them. I want them to know I am happy with where I am today because of their encouragement. Because of them, I wanted to pursue an education, but little did I would also become an educator.

I would like to acknowledge my friends for their emotional support, recognizing my work and endeavors, and cover my basic needs such as feeding me. You were all there for me when I hit my lowest points, when I was struggling to figure out who I was. Even when I thought my dreams were too big, you all reminded me that I am capable and deserving. You all celebrated with me when I learned that I am happy with who I am. You all reminded me that my worth was not determined by the traditional tokens of academia such as publications and grants. Rather, you emphasized that my worth stems from being a compassionate educator, a thoughtful researcher, and a grounded person committed to equity and justice. Finally, thanks for taking me out for boba, tacos, Korean BBQ, and Disneyland trips.

I would also like to acknowledge the following undergraduate researchers for supporting this dissertation. These educators are the forefront of engaging in community change and action. The future is bright and hopefully. Without these people, this project would not possible: Algrae Gorospe, Alondra Villegas, Ash Cruz, Carlos Henriquez, Debbie Vang, Lourdes (Lulu) Galindo, Pamela Garcia, Steven Vu, Sophia Nguyen, Susana Reyes-Valdez, Tessa Pulido, and Vanessa Comia. I would also like to thank Dr. Kasim Yildirim who took time out of his busy schedule as a visiting scholar to be a part of the after-school program. The world of STEM education is a bit more hopeful with these educators. All of the undergraduate research assistants really have encouragement me to be a better and more compassionate leader. Thank you for accepting my quirky and eccentric personality, like that one time I asked you all to carry your plastic fishes.

I would like to thank all those who have helped me with translating study protocols, surveys, flyers, IRB documents, and the data. This project literally cannot be done without your support.

I would like to thank the volunteers for Family Science Night. With over 500 family members, I could not have been able to execute this community engagement night without your time and effort. From pairing the drones and to finding batteries, it would not have been possible.

I would like to acknowledge Nancy Christensen from the UC Irvine School of Education and Pat Harriman from UC Irvine Strategic Communications & Public Affairs for their media coverage of this project. Thank you for providing a platform for this project and showcasing to the public what equitable STEM education looks like.

I would like to acknowledge the systems of oppression across race, gender, language, class, ability, and various other intersectional identities. I specifically call out these inequities as a reminder of the momentum we have gained toward social justice and equity. In addition, I call out this system as a reminder that, as a community, that our work is not complete and ongoing.

I would like to acknowledge the Newkirk Graduate Student Fellowship for their fellowship support of this project.

CURRICULUM VITAE

David DW Liu

Education

2019 *University of California, Irvine*
Ph.D. in Education
Dissertation: Growing STEMs of the Buried Seeds: Developing STEM Identities of Mexican American Girls Across Time and Space

(Visit SuperScienceSquad.com)

2018 *University of California, Irvine*
M.A. in Education

2013 *University of California, Irvine*
B.A. in Anthropology
B.A. in Public Health Policy
Minor: Educational Studies

RESEARCH

Research Interests

• Science Education • Afterschool • Diversity • Research-Practice Partnership • Design-Based Research

Publications

Book Chapter

Vu, V., Liu, D., & Begolli, K. (2019). Expressive Robotics. In Babaci-Wilhite (Eds.), *Promoting language as a human right in education through STEAM: Science, Technology, Engineering, Arts, and Mathematics,* (pp. 125-139), *Springer*.

Journal Articles
(Submitted)

Liu, D., & Kang, H. (Revise and Resubmit). Leveraged and recognized identity resources: Supporting the development of a STEM identity.

White Papers

Liu, D. (2017). Collaborative Community: Organizations Who Play Together, Stay Together. California Association of Museums.

Conference Presentations and Posters

2019 Pulido, T & Liu, D. (2019). Health Practices of Low Income Youth. Paper presentation at American Public Health Association in Philadelphia, PA.

Liu, D. (2019). Gender Differences of Latinx 5th grade students and Their Recognition of STEM accomplishments. Paper presentation at National Association for Research in Science Teaching (NARST) in Baltimore, MD.

Liu, D. (2019). Caught in the STEM Borderlands: Negotiating Hybrid Computer Scientist and Math Identities. Paper presentation at the American Education Research Association (AERA) in Toronto, Canada.

2018 Liu, D. (2018). Expressive Robotics: Movement and Robots. Oral presentation at California STEAM Symposium in Long Beach, CA.

Liu, D. (2018). Creating Video Documentaries of Community Ecosystems. Oral presentation at California STEAM Symposium in Long Beach, CA.

Liu, D. (2018). What problem is in our ecosystem? Participatory Action Research through Using and Producing Scientific Practice to Improve the Community. Chair and Paper at American Anthropological Association (AAA) in San Jose, CA.

Liu, D. (2018). A Bright Future for Latinas in STEM. Oral Presentation for Latinas/os in the US and Beyond: Diverse Perspectives on Latina/o Communities in Irvine, CA.

Lew, L. & Liu, D. (2018). Re-conceptualizing digital literacy: Addressing challenges with equity and access to technology in the midst of large-scale implementation. Paper presented at Journal of Language and Literacy Education conference in Atlanta, Georgia.

2017 Liu, D. (2017). Community based scholarship: Activism on and off the field. Session co-organizer and presenter at Digital Media and Learning Conference (DML) in Irvine, CA

Liu, D. (2017). (Re)conceptualizing a culture of STEM. Paper at American Anthropological Association (AAA) in Washington, D.C.

Liu, D. (2017). Designing afterschool computer science clubs for 5th grade Latinas. Paper presented at National Science Foundation CA INCLUDES in Anaheim, CA.

Santagata, R., Kang, H., Liu, D., Stillwell, C., Kimball, S., Long, J.J., & Ludovise, S. (2017). Project CRYSTAL: Citizen science goes to school. Poster presentation for Citizen Science Symposium at Aquarium of the Pacific in Long Beach, CA.

Liu, D., & Kang, H. (2017) Resource Flow when 5th grade Latinas Participate in Science. Paper presented at American Education Research Association Conference (AERA) in San Antonio, TX.

2016 Liu, D. (2016) Identity Work of 5th grade Latina in Science: How Resources and Figured Worlds are Hybridized. Paper at Society for the Advancement of Chicanos/Hispanics and Native Americans (SACNAS) in Long Beach, CA.

Liu, D., & Long, J.J. (2016). Participating in after school citizen science and developing authentic scientific practices. Paper at American Educational Research Association (AERA) conference in Washington, D.C.

Lao, J., & Liu, D. (2016). Preparing undergraduates for quality K-12 support in OST. Oral presentation for University-Community Links Conference 2016 in Berkeley, CA.

2013 Liu, D. (2013), Mexican orphanages and nonprofit organizations. Poster for Twentieth Annual Undergraduate Research Opportunities Program, Irvine, CA.

Liu, D. (2013), Mexican orphanages and nonprofit organizations. Oral presentation for Twentieth Annual Undergraduate Research Opportunities Program in Irvine, CA.

Research Experience

2017 - Present *Lead Researcher for Designing After School Science Programs to Connect Schools, Homes, and Communities*

Faculty Sponsor: Dr. Hosun Kang, UC Irvine

• Implementation of an afterschool STEM program and ethnographic case study of how Latinas draw on their cultural practices and resources from home and school in an after-school science program. This project received support the Newkirk Center for Science & Society.

2017- 19 *Lead Researcher for Graduate Women Engineers and Diversity Organizations*
Faculty Sponsor: Dr. James Earthman, UC Irvine
• Oral history project and phenomenological study of how graduate women engineers feel supported in their graduate experiences. This project is in collaboration with graduate women engineers from the Henry Samueli School of Engineering at UC Irvine.

2016- 18 *Researcher for Expressive Robotics: Teaching Robotics through Dance*
PI: Dr. Viet Vu, UC Irvine
• A design experiment studying how the cultural practices and resources of art (dancing) can draw on the cultural practices and resources of science (robotics) to create a hybrid space of STEAM. This project is in collaboration with the Claire Trevor School of the Arts at UC Irvine.

2015 *Researcher for Cultivating and Researching Youth Systems Thinking through Authentic Learning (Project CRYSTAL)*
PI: Dr. Rossella Santagata, UC Irvine
• Ethnographic case study of how two 5th grade Latinas draw on their cultural practices and resources from home and school in an after school computer science club. This project is in collaboration with the Francisco J. Ayala School of Biological Sciences at UC Irvine. This project received support from the Crystal Cove Conservancy, the Nicholas Endowment and UC Irvine.

2015-17 *Researcher for University Community Links Project/ Certificate in Afterschool & Summer Education (CASE)*
PI: Dr. Deborah Vandell, UC Irvine
• Longitudinal quantitative study understanding how undergraduates develop practices to prepare for out of school time leadership.

2015 *Researcher for Out of School Citizen Science Project*
PI: Dr. Jennifer Long, UC Irvine
• Design based research project on how students use scientific practices based on NGSS in an outdoor citizen science project. This project is in collaboration with the Francisco J. Ayala School of Biological Sciences at UC Irvine. This project received support the Newkirk Center for Science & Society.

2014- 15 *Researcher for Power of Discovery Study*
PI: Dr. Deborah Vandell, UC Irvine
• Longitudinal quantitative study on how quality of after-school programs predicts academic outcomes of youth.

2013 - 16 *Research and Program Evaluation Associate (practicum)*
Site: Discovery Cube OC in Santa Ana, CA
• Descriptive and RCT studies on how youth learn science in after-school programs, assemblies, and at the science museum.

2013 *Learning about Learning in Museums*
PI: David Sobel, Brown University
• Phenomenological study investigating children's developing social cognition, particularly about how and why knowledge mediates the development of diagnostic reasoning. This project received support from NSF Award #1661068.

TEACHING

Invited Speaking Events

2019 •Undergraduate Researcher Network Night Panelist. Associated Student of UC Irvine Research Mobilization Commission (February 13, 2019)

2018 •Imagining a Future of Science, Technology, Engineering and Math (STEM) for Latinas in the Community. Newkirk Center for Science and Society (June 4, 2018)

•University of California Santa Barbara's Graduate Student Speaking Series in Education (April 17-18, 2018)

•University of Southern California Pullias Center's Convening on College Access in a Digital Era: A Practioner Convening (March 9, 2018)

Teaching Assistant at UC Irvine (evaluations available upon request)

2019
- 21st Century Literacies (Online -Undergraduate Level)
- Multicultural Education in K-12 Schools (Undergraduate Level)

2018
- Children, Schools, and Cinemas (Undergraduate Level)
- Origins, Purposes, and Central Issues in K-12 Education (Undergraduate Level)
- 21st Century Literacies (Undergraduate Level with 4 discussion sections)
- Development and Learning in Education (Online - Undergraduate Level)

2017
- Children, Schools, and Cinemas (Undergraduate Level)

2017
- Outcomes of Schooling and Student Assessment (Graduate Level)
- Children, Schools, and Cinemas (Undergraduate Level)

2016
- Advance Concepts in Learning and Cognition (Graduate Level)

2015
- Advance Concepts in Learning and Cognition A (Graduate Level)
- Advance Concepts in Learning and Cognition B (Graduate Level)
- Theories of Development and Learning (Undergraduate with 2 discussion sections)
- Educational Research Design (Undergraduate Level with 3 discussion sections)

2014
- 21st Century Literacy (Undergraduate Level)

Teaching Experience in Pre K-12 Settings

2017- Present
- 5th grade Science Teaching Aide and After-school Teacher in Santa Ana, CA

2016
- 5th grade Science Teaching Aide and After-school Teacher in Santa Ana, CA
- 5th grade Science Teaching Aide at Advanced Learning Academy in Santa Ana, CA
- 4th & 5th grade Science Teaching Aide at Roosevelt Elementary in Santa Ana, CA

2015
- 5th grade Science Teaching Aide at Advanced Learning Academy in Santa Ana, CA
- 4th & 5th grade Science Teaching Aide at Roosevelt Elementary in Santa Ana, CA

2014
- Zoo Education Docent at Roger Williams Park Zoo in Providence, RI

2013
- STEM Educator at Providence Children's Museum in Providence, RI

2012-13 • Curriculum Developer at Global Connect in Irvine, CA

2010-12 • Social Studies Teaching Intern at Laguna Hills High in Laguna Hills, CA

Guest Lectures

2019 Lecture: Designing Afterschool Science Experiences
• Complex Pedagogical Designs (Undergraduate course)

Lecture: Multicultural STEM Education
• Multicultural Education (Undergraduate course)

2018 Lecture: Designing Opportunities to Learn for Students
• 21st Century Literacies (Undergraduate course)

Lecture: Challenging Deficit Perspectives in Science
• Multicultural Education in K-12 (Undergraduate course)
• Children, Schools, and Cinemas (Undergraduate course)

Lecture: Technology Use in Children's Learning
• 21st Century Literacies (Undergraduate course)

2017 Lecture: Social Relevant Curriculum and Digital Media Practices
• Multicultural Education in K-12 (Undergraduate course)
• 21st Century Literacies (Undergraduate course)

Lecture: Educational Opportunities and Charter Schools
• Children, Schools, and Cinemas (Undergraduate course)

Lecture: Culturally Relevant Pedagogy
• Children, Schools, and Cinemas (Undergraduate course)

2016 Lecture: Supporting the Authoring of a Science Identity
• Advanced Concepts in Learning and Cognition (Graduate Course)

Lecture: Sociocultural Theory
• Theories of Development and Learning Applied to Education (Undergraduate course)

2015 Lecture: Sociocultural Theory
• Theories of Development and Learning Applied to Education (Undergraduate course)

Lecture: The Intersection of Culture and Science
• Global Healthcare Systems (Undergraduate course)

Courses Prepared to Teach (Undergraduate and Graduate Level)

•Methods: qualitative methods/methodology (data collection & analysis), video in research, and research design

•Content Area: STEM teaching and learning, out of school learning, socio-cultural perspectives in education, diversity and equity in education, educational psychology, and classroom assessment.

SERVICE

Service to the University

2018 • PhD Mentor in School of Education Mentor Program

2017 • Diversity Recruitment Representative for PhD Admissions Committee
• Graduate Student Writing Mentor
• PhD Mentor in School of Education Mentor Program

2016 • Graduate Student Writing Mentor
• PhD Mentor in School of Education Mentor Program

2015 • Cohort Representative
• Media and Outreach Manager for Discover Science Initiative (DSI)
• Doctoral Student Recruitment Committee

Service to the Profession

Reviewer
• American Education Research Association Conference
• National Association of Research in Science Teaching Conference
• Society for Advancing Chicanos/Hispanics & Native Americans in Science Conference

2017-2018 • Co-Chair, Standing Committee on the Anthropology of Environmental and Science Education, Council on Anthropology and Education, American Anthropological Association

GRANTS & AWARDS

Grants and Scholarships Awarded

2019	$600	AGS UCI Travel Grant
	$700	American Education Research Association Travel Grant
2018	$5,000	New Venture Competition
2017	$10,000	Newkirk Graduate Research Fellowship
2016	$1,000	California Association of Museums Fellowship
	$1,000	Digital Media and Learning Research Fellowship
	$975	UCI Graduate Division Travel Grant
	$600	AGS UCI Travel Grant
2015	$1,000	California Association of Museums Fellowship (declined)
2013	$3,500	Getty Multicultural Undergraduate Grant
2012	$400	Undergraduate Research Opportunities Program Grant

Honors

2016 • NSF Graduate Research Fellowship Honorable Mention STEM Education

Awards

2019 • Civic Action and Social Engagement Award – Science Teaching and Learning SIG of the American Education Research Association
• Nominee for Most Promising Future Faculty Award

2018 • Graduate Student Future of the Field Award, UC Irvine Engage

MISCELLANOUS

Press Release

2019 •Pathway to a Ph.D. (Highlights of my dissertation research defense)

2018 • Partnering Locally for National Impact in Public School Innovation, pg. 25-27 (Highlights of my dissertation research and community engagement and research practice partnership)

2017 • Demystifying STEM (Highlights of my dissertation research and outreach)
• Cultivating the Next Generation of Scientists (Highlights of Project CRYSTAL where I served as researcher)
• Making the CASE for extracurricular education (Highlights of *University Community Links Project/ Certificate in Afterschool & Summer Education [CASE] where I served as researcher)*
• Collaborative Community: Organizations Who Play Together Stay Together (Case study as a California Association of Museums fellow*)*

Professional Affiliations

• American Educational Research Association (AERA)
• National Association for Research in Scientific Teaching (NARST)
• Society for Advancing Chicanos/Hispanics & Native Americans in Science (SACNAS)
• American Anthropology Association (AAA)

Research Assistants Mentored *= student received undergraduate research opportunities grants

• Designing After School Science Programs to Connect Schools, Homes, and Communities: Algrae Gorospe*, Alondra Villegas*, Ash Cruz, Carlos Henriquez, Debbie Vang, Elaine Nguyen, Lourdes (Lulu) Galindo, Mariah Morales, Maura Dennehy White, Pamela Garcia+, Steven Vu, Sophia Nguyen, Susana Reyes-Valdez, Tessa Pulido, Vanessa Comia*, and Yolanda Wang
• Graduate Women Engineers and Diversity Organizations: Grace Lin (PhD Student), Jill Pestana (PhD Student), Jennifer Schuler (PhD Student), Kristel Dupaya (PhD Student), and Lianna Fung (PhD Student)
• Expressive Robotics: Teaching Robotics through Dance: Amy Bui, Rachel Kim, Samantha Liu, Stephanie Albuquerque, Yeseung Choi, and Yejeong (Clare) Choi
• Cultivating and Researching Youth Systems Thinking through Authentic Learning (Project CRYSTAL): Jacqueline Hernandez, Jennifer Leong, Maria Galindo, Steven Vu, and Vanessa Comia
• University Community Links Project: John Yun

Research Skills

- Software
    - STATA 14
    - Vosaic (formerly known as StudioCode)
    - MAXQDA 12
    - Dedoose
    - NVivo 10
    - SPSS 22
    - HLM7

ABSTRACT OF THE DISSERTATION

Growing STEMs of the Buried Seeds:

Developing STEM Identities of Mexican American Girls Across Time and Space

By

David Da Wei Liu

Doctor of Philosophy in Education

University of California, Irvine, 2019

Associate Professor Hosun Kang, Chair

Latinas, their families, and their communities carry rich incredible resources and practices that can be leveraged to learn in STEM. Despite this strength in diversity, national reports describe that Latinas are not successful in their STEM academic achievement. The purpose of this study is to ameliorate this disconnect and understand the cultural resources and practices, including language, that Mexican American girls leverage to engage in STEM learning. Drawing on social practice theory and employing a critical ethnographic case study, I ask how do Mexican-American girls generate identity resources, during identity work, across different settings of home, school, and afterschool? Multiple sources of data were collected in an afterschool STEM program for 5th graders. Analysis of the identity development of the 4 case study girls revealed two patterns: (a) the relative nature of identity work, and (b) the importance of having a productive role to engage deeply in STEM activities. Based on these findings, I made three claims. First, having a role becomes opportunities to generate identity resources. Second, building relationships through *dichos* and *convivir* generate relational identity resources. Third, recognition work is complex and relative when taking on different perspectives of people. Three implications for future research are discussed.

CHAPTER 1: INTRODUCTION

Seeing the Glass as Half Full instead of Half Empty: Understanding 5th Grade Mexican American Girls' STEM Identity Development and Engagement across Time and Settings

Background and Problem Statement

Historically, STEM educational policy highlights a lack of STEM engagement of non-dominant youth, particularly Latinas (Lee & Fradd, 1998). Latinas are described by national reports as being unsuccessful in their STEM academic achievement (National Science Foundation & National Center for Science and Engineering Statistics, 2017). Mirroring the broader discourses in the United States, girls often associate science with cleverness and masculinity while balancing their engagement with science in very narrow perspectives (Archer et al., 2012). Critical scholars problematize this type of discourse as unsuccessful engagement in STEM unfairly judges girls, particularly those of color, while framing their gendered and racialized experiences as deficits (Zeidler, 2016). There is an increasing interest in research that adopts an asset-based approach with this population while simultaneously addressing issues of access at the intersection of gender and race (Ireland et al., 2018).

Deficit framing is prevalent and problematic. It judges and positions non-dominant communities and their girls of color as deficient without recognizing the assets that these girls contribute. Different resources are often positioned as more valuable for succeeding in education. These include cultural capital (e.g. positive attitudes toward STEM), social capital (e.g. knowing a scientist), and economic capital (e.g. robotics kits and computers) (Bourdieu, 1986; Sirin, 2005). Dominant groups achieve positions of success in STEM by acquiring these privileged resources. These "successful" dominant groups are positioned as culturally wealthy while non-dominant groups, including girls of color, are considered culturally poor (Yosso, 2005). This is problematic as it equates being unsuccessful with inequitable learning opportunities, all based on dominant forms of cultural, social, and economic capital. This paradigm further positions the student as both the problem and the solution (Zeidler, 2016). The blame is focused on community members as either not valuing the success of their youth or not having the resources to foster that success (Ishimaru, Barajas-López, & Bang, 2015; Yosso, 2005). The current project moves away from this perspective by challenging problematic ideas of what students need to engage successfully in STEM.

Contrary to the deficit narrative, girls of color carry incredibly rich cultural resources and practices which can be leveraged as opportunities to engage in STEM deeply and meaningfully. These cultural resources and practices are defined as each youth's way of doing, being, and knowing when engaging in cultural activities (Gutiérrez & Rogoff, 2003). Everyday practices include the day-to-day routines, social participation, and lived experiences of youth. Girls of color come in with a wealth of resources and experiences that could be leveraged in STEM learning. Therefore, the current project intends to capture how leveraging cultural resources and practices for those girls' productive identity work creates opportunities to develop a sense of self in STEM. Like other equity-minded educators and researchers, there is particular interest in supporting STEM learners to engage in the practices of STEM to "understand, use, and produce STEM in the different domains that make up their lives" (Calabrese Barton, Ermer, Burkett, & Osborne, 2003, p. 36). It is critical to conduct research that values and recognizes the lives of youth.

Recent studies provide some insights into the ways to support Latinas in their STEM learning. First, researchers found that Latina girls leverage funds of knowledge to connect themselves to STEM when experiences with their families at home is valued (Riojas-Cortez, Huerta, Flores, Perez, & Riojas Clark, 2008). Second, researchers show that Latinas' learning of STEM involves crossing borders between the worlds of schooling and lived experiences. For example, Mexican American students often cross these boundaries and borders between worlds, such as STEM and home (Bruna & Chamberlin, 2008). Researchers found that students bring home resources—such as ethnic pride—into the classroom. They display their ethnic pride by tagging worksheets and white boards with flags and messages in their home languages. Third, researchers highlight the importance of settings *outside* STEM classrooms, where additional resources can be leveraged in learning STEM across settings. For example, churches have been shown to support Spanish and English literacy development and practices by using English in church and Sunday school (Ek, 2009). Despite these insights, the processes and mechanisms by which young Latinas come to engage meaningfully in STEM while navigating multiple settings is still under-studied and under-theorized. This makes it difficult to design learning environments that support Latinas' meaningful engagement in STEM.

Present Study

The purpose of this project is to better understand the cultural resources and practices that Mexican-American girls leverage to engage in STEM learning. This project pays particular attention to how resources from various settings, when they are leveraged and recognized, become identity resources (Liu & Kang, Under Review). By *identity resources*, I mean "a form of leveraged and recognized resources, during identity work, resulting in generating new meanings about self and STEM over time" (Liu & Kang, Under Review, p. 2). Understanding how the resources of non-dominant youth facilitate development of a sense of self will guide educators and researchers to better support those youth's powerful learning in STEM.

This project focuses on 5th-grade Mexican-American girls as a case of the girls of color and their identity development in STEM. Studies have emphasized the need to understand intersecting factors of race and gender in STEM (Carlone & Johnson, 2007; Freehill, Di Fabio, Hill, Traeger, & Buono, 2007). Previous research and policy reports has foregrounded the importance of settings, particularly after-school programs, for deep and meaningful STEM learning (National Research Council, 2015). Much of the literature indicates a sharp drop of STEM engagement as students transition from elementary to middle school (Archer et al., 2010; Carlone, Scott, & Lowder, 2014). There is even emerging literature that argues that interests in STEM and high STEM engagement are never even cultivated at a young age (Anderhag et al., 2016; Tytler et al., 2008). Therefore, this project looks at 5th-grade Mexican-American girls across different settings.

The research question that guides the analysis are: how do Mexican-American girls leverage resources from home, school, and afterschool during identity work in an after-school program to generate identity resources?

Study Significance

Theoretical Significance. This project builds on the theoretical foundations of social practice theory by paying attention to identity work that takes place across *different* types of space and time. I build off the theoretical foundations of identity work across settings and also the artifacts and actors in these different settings. Furthermore, this project advances existing knowledge bases regarding Mexican-American girls' STEM identity development. Finally, this study adds to the burgeoning literature on Latinx students, and in particular Mexican-Americans students in STEM.

Practical Significance. This project continues to build on the praxis of how to implement afterschool STEM activities that support Mexican-American girls' engagement in STEM. As a result of this project, a yearlong after-school curriculum has been developed (3 units and over 25 lesson plans, see Appendix A). The curriculum, as a product of this project, can be shared with practitioners and is an instructional resource for teachers and educators. Furthermore, because of this project, a collaboration between researchers and the partnering field site has occurred for the last 3 years. This collaboration has included directly supporting the partner site in their educational endeavors, building partnerships and trust between researchers and educators, and working directly with undergraduate research assistants and students to make a change and impact in teaching and learning.

Overview of the Chapters

Chapter 2 provides a literature review that synthesizes 1) various methodologies and research findings undertaken by researchers who have studied the phenomenon of the cultural resources of Latinx and Latina, students and the learning of these students across settings and over time, and 2) lessons learned and gaps in the literature about how Latinas succeed and learn across academic disciplines broadly and in science in particular, with a focus on the histories, resources, and social practices of this population. Chapter 3 presents a theoretical and conceptual framework that guides the inquiry of the focal phenomena. Chapter 4 describes study context and methodology (i.e., a critical ethnographic case study). In Chapter 5, the identity development of Latinas is discussed across four different cases, highlighting four different patterns of STEM identity development. Chapter 6 presents conclusions and implications of this work. Recommendations for practice are also discussed.

CHAPTER 2: LITERATURE REVIEW

Supporting Latinas in their Learning and Engagement through

Counter-Spaces, Education, Family, Home Pedagogies, and Linguistic Resources

Introduction

The purposes of this literature review were to 1) present the ways various researchers have studied the phenomenon of Latinx and Latina students' cultural resources and practices and their learning both across settings and over time, and 2) establish both what is broadly known—and gaps in the literature—about how Latinas succeed and learn across academic disciplines, and science in particular, with a focus on their histories, resources, and social practices.

The specific questions that guided this literature review were: 1) What cultural resources and practices do Latinx students, particularly Latinas, leverage for their learning broadly, with a particular interest in science?, 2) From which settings do Latinx students draw their cultural resources?, 3) Who are the actors that may play a role in leveraging these resources?, and 4) What ways do other actors support Latinas and their learning?

For the purpose of this literature review, I designated Latina/o/x as the main demographic group of study. The girls in our case study shared one similar ethnic background and all reported Mexican ancestry. It is also important to remember that there are multiple ethnic identities that the case study girls claimed under the broad category of Latina/o/x, including El Salvadorian and Central American. Moreover, one of the case study girls strongly identified as a member of a tribe indigenous to Orange County.

The literature review presented here potentially treats all Latinx racial and ethnic backgrounds as homogenous. Though the aim is *not* to assume that all Latinx students, communities, and families are the same, the literature is quite thin in regard to specific students and their ethnic backgrounds (e.g., Mexican vs. El Salvadorian). It is important to understand that there is more variation within group than variation across this group. This literature review indicates if the research cited identified a specific ethnic group. Otherwise, the term “Latinx” is used to describe the demographics of this group, consistent with the broader literature.

Methods

This literature review was conducted in two phases. In the first phase, a list of education related journals with a particular interest in science and STEM was generated. These included *American Educational Research Journal*, *Journal of Research in Science Teaching*, *Science Education, Cultural Studies of Science Education*, and *Journal of Learning Sciences*. A list of keywords was generated (e.g., Latina, Latinx, Latino, Mexican, and Mexican-American) and used in a search via Google Scholar. For each result of this search, the abstract was read to ensure that the article qualified based on a set of inclusion criteria (described below). Notes about the phenomena, findings, methodologies, and future directions of each article were recorded in an Excel spreadsheet. Additional literature was found based on the reference list of the selected articles. Finally, the spreadsheet was looked across to identify emergent themes. The initial search resulted in 35 articles. After reviewing inclusion criteria and the reference list of each selected article, a total of 16 articles were reviewed about 5th-grade Latinas’ STEM resources across settings. This first literature search resulted in the literature review for this project. To conduct the second round of this literature review, a list of journals in science, mathematics, education, and learning sciences were identified. This list included *American Educational Research Journal*, *Journal of Research in Science Teaching*, *Science Education*, *Cultural Studies of Science Education*, *Journal of Learning Sciences*, *Cognition and Instruction*, *Mind, Culture, and Activity*, *Educational Studies in Mathematics*, *Journal for Research in*

Mathematics Education, *Journal of Mathematical Behavior*, *Mathematical Thinking and Learning*, *Journal of Mathematics Teacher Education*, and *the International Journal of Math Education in Science and Technology*. Three additional journals related to culture were also searched: *Journal of Latinos and Education*, *Journal of Latina/o Psychology*, and *Anthropology and Education Quarterly*. The list of keywords for this search was as follows: Latina, Latinx, Latino, Mexican, Science, and identity.

Included literature was selected based on the following criteria: whether the research was empirical, Latinx were the ethnic group, with a focus on Latinas, and the topic was learning of an academic discipline (e.g., science, mathematics, or literacy). The literature selected for this review includes participant who are in the K-12 age range but also was open to undergraduate students if it ties back to learning an academic area such as science, mathematics, and literacy. Other learning environments (e.g., after-school programs and museums) were also included in the literature review. Studies were selected if they described some sort of phenomenon regarding Latinx populations and learning, with a particular focus on Latinas.

A total of 115 articles were initially identified and the abstract of each was read to ensure that the article qualified based on the inclusion criteria. Articles needed to be empirical; this criterion resulted in 36 articles ultimately reviewed. Finally, a spreadsheet was generated to identify emergent themes. The spreadsheet included the sample size/number of cases, ages or grade of participants, the methodology, the setting of the study, and the ethnic group represented in the study. Broadly, the academic content areas covered in the literature review included science (18 studies), mathematics (9 studies), and language/literacy/bilingualism (11 studies).

Findings of Literature Review

In searching the very narrow research literature of Latina's and their learning (a total of 36 studies), four themes emerged so far. The first theme is learning in counter-spaces along with traditional schooling practices and environments. In particular, this theme focuses on ways in which Latinas can access resources across multiple settings to support their learning in traditional schooling (Allen & Eisenhart, 2017; Bruna, 2007; Parker, 2014). The second theme is *la educación* (education) as a responsibility of *la familia* (family). In particular, *educación* is not limited to traditional school practices (Delgado-Gaitan, 2005; Villenas, 2005) but includes family engagement across moral, ethical, and community values (Espinoza-Herold, 2007). The third theme is that learning builds on the home and family as a form of pedagogy. This theme primarily draws on research from museum studies and after-school programs to understand how home practices such as cooking and speaking connect to support learning and family engagement (Sayman, 2013; Tenebaum & Callanan, 2008). The fourth and final theme is leveraging linguistic and bilingual resources to support learning. This theme draws on canonical research on bilingualism (Jiménez, 2000) and recent research on linguistic resources (LópezLeiva, Torres, & Khisty, 2013; Stevenson, 2015).

Together, the review of the literature suggests that Latina students draw on various cultural resources and practices, such as linguistic resources, from their home settings to succeed in learning, particularly science. In fact, these resources, particularly linguistic resources, emerge from home and family pedagogy. Within this home and family pedagogy, *la educación* is central to *la familia*, where students use their cultural resources and histories to create counter-spaces against traditional schooling practices and succeed academically.

Theme 1: Learning in Counter-Spaces Along with Traditional Schooling Practices and Environments

Within this theme, I will discuss eight empirical studies containing three subthemes. I first describe how traditional schooling practices often problematize Latinas and their communities in the struggle for educational success. Then, I discuss how culturally congruent pedagogies can be an opportunity to transform social inequities for Latina students. Thirdly, I discuss transformative learning environments through the creation of counter-spaces in which academic and intellectual opportunities occur. Within this theme, I argue that learning in counter-spaces alongside, rather than against, traditional schooling practices and environments supports Latinas' educational success.

Traditional Schooling Practices and Environments. Traditional school discourses often normalize unfortunate circumstances for Mexican-American immigrant youth. For Latina students in particular, it is up to the schools to create opportunities for academic success in this context. In a longitudinal study of high school Mexican Latinas interested in STEM, such discourses are framed as needing to be "brought up" and to "have a better life" (Allen & Eisenhart, 2017). Schools are described as not engaging with inquiry and culturally congruent practices. For example, in one study, 7^{th}- and 8^{th}-grade Latina students received teacher-directed lessons with worksheets and textbook-based questions, and coupons for correct answers that could be exchanged for candy (Parker, 2014). Within these traditional environments, there is potential to improve learning opportunities for Latina students.

Traditional schooling practices could be improved to better support Latina students and their learning, particularly in science. Researchers have identified the need for culturally congruent practices in traditional school settings. This could involve the use of science inquiry approaches, including leveraging the diversity of experiences, materials, use of native languages, linguistic scaffolding, and sharing of scientific authority with Latina students (Parker, 2014).

Other traditional schooling practices that have been suggested include college preparation programs, teacher learning communities, and alteration of school discourses to challenge notions of Latinx community obstacles (e.g., a lack of resources, a lack of documentation) due to social class and migration history (Allen & Eisenhart, 2017). These improvements can be driven by introducing different pedagogies to support Latina students.

Culturally Congruent Pedagogy. Pedagogically, teachers can support Latinx students to engage in science deeply and meaningfully. For example, in an integrated science-literacy classroom, Mexican 3rd-grade students incorporated texts and hands-on exploration. This allowed students to contribute their assets to the classroom and co-construct meaning with their peers and teachers (Valeras, Pieper, Arsenault, Pappas, & Keblawe-Shamah, 2014). Literature has also suggested that informal literacy practices can travel to formal school settings and create hybrid practices. High school Mexican-Latinas who engage in tagging (i.e., a term for writing the name of your country, region of origin, or person), show informal assistance, claims of who they are proud of, and helping others (Bruna, 2007). For example, in a pig dissection activity, students were to measure the length of the pig intestines. Students did so on a white board, with every measurement written, tagged the whiteboard to include both the scientific practices and informal literacy practices. Such equity-based pedagogy can be scaffolded by focusing on Latina students' interests and experiences.

Beyond proposing learning environments to support equity-based learning for Latinas, studies have also suggested the importance of pedagogy built around students' interests and experiences. In one study, pre-service teachers in an after-school math club with Mexican students both successfully and unsuccessfully leveraged culture as an instructional resource (Vomvoridi-Ivanović, 2012). In *unsuccessful* events, side conversations were deemed irrelevant to the task (e.g. discussion of Myspace, Pokémon, and cartoons) or discussions did relate to the mathematical content but only on a personal level (e.g. seeing 3 dimensional drawings and 3 dimensional movies). In *successful* events, preservice teachers were able to ask students to recall their experiences from previous sessions to make sense of and participate in activities (e.g., measurement and following a recipe to make orange juice). Drawing from ideas of creating culturally congruent school learning environments, out-of-school learning environments have provided similar learning opportunities.

Counter-Spaces to Support Learning. In thinking about the learning environment, after-school programs and other nontraditional learning settings have often been described both as spaces where academic and intellectual opportunities occur and are unlike school. These "third spaces" (Gutiérrez, Rymes, & Larson, 1995) are defined as not like school but similar to school in function. However, for the purpose of this literature review, I consider third spaces to be counter-spaces. I explicitly use "counter-spaces" to reject hierarchical roles and structures, address social and political contexts, and the normative scripts of what is expected in learning (Hirst & Renshaw, 2004).

In particular, I draw on a literature that sees counter-spaces as means of resisting normative schooling practices. This resistance is political in nature and grounded in social justice. These counter-spaces leverage skills and resources for thinking but not in the same way that traditional school settings do. Often, these settings are designed to offer alternative academic learning environments that center on students' home languages, communities, and knowledge as learning resources. For example, in an afterschool math context, 3rd- to 6th-grade Latinx students were provided an alternative experience with math that supported their mathematical engagement and connected the concepts to who they were, their values, integrated experiences, languages, and communities (Gutiérrez, Willey, & Khisty, 2011). In this example, one language was used to understand or read a problem. Another language was used to express ideas in group work. Students even stated that community-based mathematical investigations allowed them to resist current structures of society and link their community experiences to math concepts. For example, the students engaged in math by conducting surveys on robberies in the neighborhood. Other counter-spaces, such as the Emerging Scholars Programs and similar mathematics workshops, provide opportunities for Latinas to manage gender and class identities as they develop their interests in math (Oppland-Cordell, 2013). For example, an 18-year-old Latina in the aforementioned study was recognized by her workshop peers and instructors in a way that valued her mathematical skills and countered the racialized experienced she had had with other teachers. Within these after-school programs, counter-spaces offered students an opportunity to engage with academically rigorous content outside of traditional schooling practices.

Further evidence shows that counter-spaces can be generated by intersecting the everyday and academic languages of Latinas. In one study, Latina mothers and their 12-year-old daughters leveraged their experiences in a bilingual science family workshop (Kayumova, Karsli, Allexsaht-Snider, & Buxton, 2015). These mothers and daughters expressed a need for educational spaces where "social, cultural, ethnic, gendered and language experiences and their ways of knowing are validated" (Kayumova et al., 2015). Within this study, students, parents, teachers, and researchers worked together to discuss how to build a path to college for their daughters. Similarly, other studies have shown that counter-spaces, particularly mother-daughter centered spaces, can include places such as lunch tables, university classrooms, and school cafeterias. Within those everyday counter-spaces, women engaged in educational inquiries, enacted critical pedagogies, and discussed future academic identities (Villenas, Godinez, Bernal,

& Elenes, 2006). It is clear that these everyday settings and academic practices can come together within these counter-spaces.

Equitable Teaching and Designing Learning Environments for Latina Students. In sum, the literature identified two areas that can be improved to support Latinas and their academic learning: 1) pedagogy and 2) the learning environment. Often, traditional schooling practices put Latina students on the margins; research has described the challenges of these traditional learning environments at length (Allen & Eisenhart, 2017; Parker, 2014). Opportunities to engage in productive learning have been identified as successful improvements to these practices. This includes engaging in culturally congruent practices such as linguistic scaffolding, and challenging the notion of Latina community obstacles (Allen & Eisenhart, 2017; Parker, 2014). Pedagogically, teachers can support Latina students by engaging students' informal literacy practices and assets to co-construct meanings of learning (Bruna, 2007; Valeras et al., 2014). Drawing on students' interest and experiences, teachers are also able to successfully leverage culture as an instructional resource (Vomvoridi-Ivanović, 2012). Beyond just pedagogy, it is important to pay attention to space and settings.

It is also critical to understand the learning environments in which equity-based pedagogies are enacted. These aforementioned *counter-spaces* (Gutiérrez et al., 1995), in particular after-school programs and informal learning environments, afford opportunities for students' alternative experiences. These academic experiences are centered around students' home languages, communities, and funds of knowledge as instructional resources (Gutiérrez et al., 2011). Students often develop their identities as they develop their academic interests (Oppland-Cordell, 2013). By bringing together academic and everyday practices within these counter-spaces, students engage in deep educational inquiries and sense-making (Kayumova et al., 2015; Villenas et al., 2006). In particular, learning in counter-spaces *alongside* rather than *against* traditional schooling practices has been shown to support Latinas' educational success.

Theme 2: *La educación* (education) as a Responsibility of *La Familia* (Family)

Family and education are two concepts that have emerged from the literature of Latinx education. The Latin American notion of *educación* resides in the family and includes moral, social, and personal responsibilities (Valenzuela, 1999). Learning activities, both within school and outside of school, fall into the domain of *la familia* and *educación* as reflection of the family (Valdes, 1996). *Educación* is not merely a school-based practice (Delgado-Gaitan, 2005; Villenas, 2005). *Educación* also includes family engagement and educational aspirations, morals, ethics, and senses of belonging to a community (Espinoza-Herold, 2007). In fact, family and home become a place for Latina mothers to play a role in children's *educación*. Family traditions, beliefs, values, stories, cultural practices, personal literacies, and ways of knowing are described as mothering pedagogies (Durand, 2011; Elenes, González, Bernal, & Villenas, 2001; Urietta, 2007). The importance of family and learning are often documented in counter-spaces (Gutiérrez et al., 1995) and include cultural resources and practices often not legitimized in traditional school learning environments.

Within this theme, I will discuss ten empirical studies involving two sub themes. First, I describe how Latinx families build networks of support. Building on this network means creating a foundation of familial recognition and providing advice to support academic endeavors. Then I describe how Latinx families engage in family centered learning. This includes direct teachable moments, particularly in science practices and funds of knowledge, and building family cohesion. Within this theme, I argue that *la educación* is a responsibility of *la familia* and includes both academic practices and building a social network to support Latinas in their educational progress.

Networks of Support. Latina students often find that the support from their families and communities enables them to build strong networks. High schoolers, with Central Mexican roots who pursued STEM, often discussed the resiliency they developed from their parents or primary caregivers from daily interactions (Stevenson, Gallard Martinez, Alejandro José Brkich, Flores, & Claeys, 2019). For example, these Latinas interacted, negotiated, and leveraged bilingual resources to help elders through the dominant culture. This solidified mutual support and developed individual resilience. In one case, Amelia described supporting her grandfather and how this *consejos* (Delgado-Gaitan, 1994), also known as talk and advice, helped her overcome adversity and excel in school. Moreover, serving as a language broker for her grandfather helped her strengthen family relations, re-affirm her support network, and build a sense of self efficacy as she pursued her STEM interests. In the literature on recognition work, undergraduate Latinas in STEM are often recognized by their family members to support their STEM identity development (Rodriguez, Cunningham, & Jordan, 2017). Furthermore, family members themselves often directly provide support and teachable moments to their children.

In the literature, Latinx families have been documented as disrupting the discourse that their families do not support children's education in ways that are consistent with formal schooling (Valenzuela, 1999). Latinx parents have significant impact on children's success. In one study, Latina mothers often shared *cuentos* (stories) and *consejos* (advice) with their 12-year-old daughters in a bilingual family science workshop (Kayumova et al., 2015). These *cuentos* and *consejos* often validated daughters' home languages, cultural practices, familial knowledge, and appropriate school-based knowledge and learning. In another study, 9- to 12-

year-old Mexican students often referenced their families, in particular their fathers, as a source of strength for important and useful information (Jiménez, 2000). Fathers are referred to as sources of literacy learning and support, including giving money for books, going to the library, and using *consejos* of how they should be reading to prepare for academic success. In short, these support systems and direct teachable moments provided Latinas an opportunity to succeed academically.

Family Centered Learning. Latinx families often use family time to not only engage in direct teaching moments but also to create cohesiveness and family culture. In one study of Mexican families with children ages five to fourteen in a science museum in Mexico, family-centered learning experiences were often emotional and affective (Briseño-Garzón & Anderson, 2012). Families see themselves as units and learners. For example, in the Mexican socio-cultural context, families are built on mutual reliance, cohesion, and a unique intra-familial culture that is a result of the joy of *convivr*. *Convivir or convivencia*, which is best translated as family bonding time, where family conversations are built on past events and individual experiences (Hilke, 1987). Often, science learning experiences within Latinx families are more than just learning academic practices and content. In another study, families with children ages one to fourteen in a science museum in Mexico, families describe their positive family experience as an educational experience as well as learning more about each other, family dynamics, and interactions (Briseño-Garzón, 2013). In terms of cognitive outcomes (e.g. factual or declarative understandings of scientific topics), adults and children developed personal interest in scientific topics and memories of concepts. Beyond merely a social and family building experience, Latinx families engaged in teaching moments with their children.

Teachable moments include the parent-child everyday conversations which has implications for early science learning. One study of forty Mexican families with young children studied parent-child interactions in two activities: a direct activity and a visit to a local science museum (Siegel, Esterly, Callanan, Wright, & Navarro, 2007). A within-group analysis of Mexican parents with basic schooling and Mexican parents with higher levels of schooling showed both had rich explanatory conversations with their children on the direct activity. This scientific talk included content-specific explanations and scientific terminology. In the museum, parents with higher level of schooling were more directive. Within the open-ended activity of a museum visit, activities were more collaborative between the child and the adult. In another study of four parent and child groups in a US science museum, Mexican parents with four-year-old children were able to evaluate evidence and parents asked children concept-related questions regardless of educational attainment (Solis & Callanan, 2016). Many of these conversational science practices include questioning, making predictions, and evaluating evidence. It is clear that experiences with families affords learning opportunities for Latinx children despite parents' educational attainment.

Building Social Networks and Direct Teaching Moments is Part of *La educación* (education). Learning activities, both within school and outside of school, fall into the domain of *la familia* and *educación* is reflection of the family (Valdes, 1996). *Educación* includes the supportive networks of belonging as well as informal and formal educational practices to succeed in school and life (Delgado-Gaitan, 2005; Espinoza-Herold, 2007; Villenas, 2005). Moreover, the network of family relations has been leveraged to support Latinas in developing resilience (Stevenson et al., 2019) and recognize and celebrate the success of Latinas (Rodriguez et al., 2017). Often, *cuentos* (advice) and *consejos* (stories) support Latinas in their academic journeys by validating cultural resources and academic practices (Kayumova et al., 2015). Beyond a support system, Latinx families have also been shown to have direct teaching moments in science related activities in informal learning settings such as science museum.

Moreover, *educación* includes the direct teaching moments that parents have with their children. Parents, alongside their children, develop personal interest in scientific topics and synthesize scientific information during family bonding time (Briseño-Garzón, 2013). Mexican parents also evidence rich scientific explanatory conversations even when controlling for educational attainment (Siegel et al., 2007). This literature challenges deficit notions of low academic achievement for low-income minorities, especially for Latinx parents and families (Hursh & Henderson, 2011). It is clear that strong networks of families and the direct teaching moments in family-centered learning can be leveraged to support Latinas in their educational success.

Theme 3: Learning Builds on the Home and Family as a Form of Pedagogy

The home setting has been documented in the literature as the foundation for Latinas' success in education. In a study of Latinas ages 16 to 18 attending a STEM academy, ethnic identity from the home was navigated frequently as Latinas participated in STEM (Sayman, 2013). Often these identities included speaking Spanish at home and doing "everything Mexican" such as church, cooking, living, lifestyle, culture, and time with parents (Sayman, 2013). Research has shown that Latinx students who have greater academic success often recognize and embrace the struggle between the culture of schooling and their own ethnic identities (Roche, Ghazarian, & Fernandez-Esquer, 2011). Through these experiences and navigations, Latinas can question constructs and "become aware of something from two different angles" (Delgado Bernal & Elenes, 2011, p. 102). In other words, this experience becomes a productive struggle and negotiation and offers Latinas different perspectives to engage in their learning and sense-making.

Within this theme, I will discuss eight empirical studies, describing two sub-themes. The first subtheme draws on mothering pedagogies. Mothering pedagogies are defined as when Latina mothers, dedicated to their children's *educación,* enact family traditions, beliefs, values, cultural and personal literacies, and ways of knowing (Durand, 2011; Elenes et al., 2001; Urietta, 2007). The second sub-theme is community practices, known as barrio-approaches (Irizarry & Raible, 2011), for Latinas to succeed academically. Within this theme, I argue that family-based pedagogy supports Latinas in productive academic learning and engagement by drawing on and building from family- and community-based resources and settings.

Mothering Pedagogies. Latina mothers play a critical role in the success of young Latinas' *educación*. Latina mothers enact these mothering pedagogies through family traditions, beliefs, histories, values, cultural and personal literacies and ways of knowing (Durand, 2011; Elenes et al., 2001; Urietta, 2007). Examples include mothers advocating on behalf of their children. For example, in the context of bilingual science workshops, mothers often encourage their daughters to identify with school and broader community practices (Espinoza-Herold, 2007). Mothers will learn English to assist daughters with homework, leveraging non-academic languages to learn science (e.g., TV news, documentaries, newspapers), and sharing their own life stories of resistance, survival, and sacrifice (Kayumova et al., 2015). The conceptualization of mothering pedagogies draws from the notion or *Marianismo* (i.e. the female gender roles) which often view the Virgin Mary as a role model (Becerra, 2011). The mother has the central role *en la casa* (in the home) and the father provides a marginal role *en la calle* (outside of the home) as the provider. To this end, the mother is responsible for teaching and transmitting values and beliefs about the family and their cultural roots and heritage. The mother becomes the central figure that daughters try to emulate and become (Espinoza-Herold, 2007). Often, these everyday experiences of Latinas mothers offer their daughters an opportunity to teach, learn, and develop communal ways of knowing (Villenas et al., 2006). Moreover, mothering pedagogies compliment other approaches to support Latinas and their learning.

Community Practices and Barrio-Based Approaches. Another approach to supporting Latinas in their learning is through barrio-based approaches to teaching and learning. Barrio-based approaches utilize culturally responsive pedagogies in learning environments that focus on understanding the social and cultural connections and networks within the Latinx community (Irizarry & Raible, 2011). Moreover, barrio-based approaches are focused on students and their cultures and not on blaming either families or languages for underachievement. In family-based science activities at school, Mexican-American parents often use their cultural knowledges to spark conversations of wonder and inquiry with their three- and four-year-old children (Riojas-Cortez et al., 2008). For example, when making tortillas in family science activities, parents often used vocabulary involving observing and describing the changes of the *masa* (dough). Words such as *volumen* (volume), *área* (area), and *combinar (*combine) were also used when engaging with children. These barrio-based approaches often have led to productive engagement of Latinx students in other academic settings.

Within after-school programs, community practices and barrio-based education have led to productive engagement in academic disciplines like math. For example, Latina mothers who co-developed an after-school math program for 4th graders were able to engage in algebraic thinking and geometric reasoning based on community practices (Willey, 2008). For example, parents leveraged their network to identify a business or service provider to explain daily operations. Parents escorted students to these businesses on field trips. After the field trip, students started to engage in different conversations about materials they saw and engaged with mathematical concepts such as diameters, angels, inches, and degrees. Throughout these experiences, mothers guided the students through the knowledge of these concepts. In another after school program, 3rd- through 6th-grade Latinx students in an after-school math club grounded mathematical investigations in community-based contexts that positioned students and their families as experts with unique experiences (Turner, Gutiérrez, Simic-Muller, & Díez-Palomar, 2009). For example, students created surveys about the feelings of immigrants and met together to tabulate and organize data. Students had a desire to understand their community members' perspectives, personal histories, and experiences which shaped how they developed their survey. These projects became important to students as their engagement was grounded in students' community knowledge alongside their mathematical knowledge.

Centering the Home and Community to Engage Latinx Students. In sum, the home and family setting support Latinas and their learning and educational success. Mothers play an important role by enacting mothering pedagogies. This includes cultural and family traditions and practices (Durand, 2011; Elenes et al., 2001; Urietta, 2007). Often these mothering pedagogies offer daughters an opportunity to engage deeply and meaningfully in their academic endeavors (Villenas et al., 2006).

Theme 4: Leveraging Linguistic and Bilingual Resources to Support Learning

As literacy research has developed from a socio-cultural perspective, educators and researchers have expanded on ways in which Spanish can be used as a literacy practice to engage students in their learning. These markers of language have been considered non-mainstream and even debilitating for student learning (Moya, 2000). However, as research on identity and learning has moved to be more socially constructed through assigned meanings, language has been acknowledged as an integral part of academic learning and engagement. Language is not only used as a way of communicating but of understanding, making meaning of the world, and developing identities (Gee, 2000; Rosebery, McIntyre, & Gonzalez, 2001). Researchers have examined the sociohistorical and sociopolitical context of language usage of bilingual Latinx students. In particular with bilingual students, gestural, oral, and textual models of language and science have allowed students to engage more deeply in science (Dominguez, Allexsaht-Snider, & Buxton, 2018). This draws on the idea that bilingual resources can diversify the burden for Latinx students and expose ideas of science across contexts (Lee & Buxton, 2013). In particular, the home and family setting are contexts in which students can draw on their linguistic resources.

Within this theme, I will discuss fourteen empirical studies by describing two sub-themes. The first sub-theme draws on Spanish and bilingualism as an instructional resource. In this sense, the theme focuses on how Spanish and bilingualism, as instruction resources, support the engagement of students and learning materials. This can better support instruction by breaking down language barriers and allowing students to engage using both Spanish and English (Carter & Chatfield, 1986; Garza & Arreguín-Anderson, 2018; Khisty, 1995). The second theme builds on the idea of bilingualism as being bicultural and a linguistic resource. Rather than understanding Spanish as just an oral language, this theme builds on meaning making beyond just comprehending. This theme includes the social, cultural, historical, and political nature of language based on lived experiences (LópezLeiva et al., 2013; Stevenson et al., 2019). Furthermore, this theme also includes linguistic resources such as *dichos* (proverbs and sayings) and *adivinanzas* (riddles) to support Latinx students and their learning (Arreguín-Anderson & Ruiz-Escalante, 2018; Espinoza-Herold, 2007). Within this theme, I argue that the resources that support Latinas in their academic learning include both bilingual and instructional resources (e.g., the talk that Latinas engage in during instruction) and the bicultural and linguistic resources (e.g., the meaning making and social and cultural meanings of the talk that Latinas engage in during learning).

Bilingualism and Spanglish as an Instructional Resource. Beyond STEM education, language learning and literacy have been empirically studied as resources to support Latinx students' academic engagement and success. In a study of six high schools, language and culture were identified as valued for Latinx students who have achieved high levels of academic achievement (Lucas, Henze, & Donato, 1990). Previous literature for elementary school students has recognized success with Latinx students when leveraging Spanish in instruction (Carter & Chatfield, 1986). For example, in a case study of a bilingual elementary school, Latinx students have stated that they fear that their identities would not be represented in the curriculum without the use of Spanish (Carter & Chatfield, 1986). The threat that students stated was the fear of losing a part of themselves and creating a "gaping hole in terms of their identities" and being unable to draw from their collective stories as a strength in education (Jiménez, 2000, p. 995). If bilingual resources were leveraged, barriers to productive engagement and academic success would be removed.

Researchers have argued that willingness to engage students with Spanish opens opportunities to develop effective instructional practices and create genuine relationships with students. Teachers have been known to use Spanish to process higher order cognitive skills such as problem solving in mathematics (Khisty, 1995). Moreover, the same teachers allowed cooperative group work that gave Spanish speakers an opportunity to interact with other students in their classroom (Garcia, 1994). Creating a learning environment of bilingualism allows for students to interact and collaborate with each other. In one study of a 4th-grade science classroom, Latinx students used language flexibly to speak, read, and write. They were also integrating artifacts as they navigated science texts and ideas (Garza & Arreguín-Anderson, 2018). This fluidity in language both affords and embraces student's bilingualism as well as allows for meaningful sense-making of bilingual students.

Bilingualism, which is mostly seen in dual-language immersion schools, has been cited as an opportunity for Latinx students to engage deeply in academics. In terms of language use, researchers have noted the use of *chanza* (Spanish and English or "Spanglish") have been used to co-construct engagement in mathematics and use students' linguistic knowledge (LópezLeiva et al., 2013). In a study of 4th-grade Latinx students, *chanza* has been noted to boost attention and participation and enhance the quality of collaboration and meaning-making within groups. Students are also able to negotiate mathematical procedures such as subtraction and probabilities. These language barriers may be challenging as students enter the social world of schools where English is mainstream (Brown & Souto-Manning, 2007). However, using their own words and bilingual resources, students are able to interact with the world of schooling and bring structures of their social lives into the classroom community (Dyson, 1993). These interactions allows students to acquire and access experience as a resource to participate in the classroom and the school community (Christian & Bloom, 2004). The importance of language also becomes a political struggle for the Latinx community in terms of their pursuit of education. For example, in a 4th-grade science class of Latinx students, the teacher used both English and Spanish to flexibly achieve and promote students' understanding of science (Garza & Arreguín-Anderson, 2018). The teacher spoke in Spanish and legitimized the language. Together, prior studies suggest that failure to expand and elaborate on these linguistic resources may limit opportunities to engage in STEM. Beyond instruction, this literature also prompts researchers to consider language as a cultural and linguistic resource and include the socio-cultural meaning of language use.

Biculturalism through Bilingualism as a Linguistic Resource. One important home resource is the use of language, which has been documented in academic learning. Spanish is characterized by strong oral traditions (Burciaga, Christensen, & Christensen, 1997); meaning is transmitted interpersonally and inter-generationally, and social discourse is embedded in highly contextualized situations. It is important to remember that linguistic resources, particularly from home, are embedded in the historical and structural histories of Latinx students' lives. Language and home cannot be separated (Ek, 2009). The use of heritage languages by Latinx youth aids in maintaining relationships with their home, families, and communities while still maintaining their own identities (Stevenson et al., 2019). In these moments, linguistically and culturally rooted identities afford opportunities to learn STEM (Stevenson et al., 2019). These linguistic resources could be either literally using Spanish to engage with sense-making or the use of cultural linguistic resources such as proverbs (*dichos)*.

As discussed above, *chanza* (Spanglish) has been used as an instructional resource for teaching but is also laden with cultural meanings. The use of *chanza* or "Spanglish" is literally a cross of worlds between Spanish and English. *Chanza* can be used as a tool to learn STEM and represents a bilingual resource (Bruna, 2007; LópezLeiva et al., 2013). Mexican-American students cross these boundaries and borders often to play between worlds (Bruna & Chamberlin, 2008). This is similar to the literature on third spaces in which students connect their own "first space" ways of being with those of the "second space" academic discourses and settings (Moje et al., 2004). Other research has indicated literacy practices out of school *can* and *do* travel to formal classroom settings, producing hybrid discourses (Kamberelis, 2001). From the literature so far, there is clear indication that leveraging such resources creates new opportunities for learning. This further focuses our attention to the fact that learning is not disconnected from the lives of students and great care must be placed on these other settings of youth.

One aspect of Latinx students' lives that is connected to their *educación* is their family and social networks (see Theme 2 and 3 for more information) and the advice that they receive from their families. As part of their social networks and families, Latinx students can leverage many cultural and linguistic resources to persevere through their learning and education. As both a home resource and a linguistic resource, *dichos* (popular saying/idioms) have been studied by researchers as using experiential knowledge. *Dichos* are "proverbs, sayings, adages, maxims, and apothegms. These short, pithy comments are often repeated to illustrate a point or to give advice. *Dichos* reflect the community's wisdom, superstitions, and prejudices, which are based on life experiences" (Rodriguez-Rabin, 2005, p.10). One example of *dichos* is the famous "*Sí se puede*!" (Yes, we can). *Sí se puede* was coined by the co-founder of the United Farm Workers of America, Dolores Huerta, and used during Cesar Chavez's twenty-five day fast (Rodriguez, 1998) and has since been adopted by many activist groups. *Dichos* are used not only in Latin American countries but also Mexican-American communities.

These *dichos* are often rich and varied and carry communicative traditions within a Western society. For example, in one study of a college Latina, despite her mother knowing little about the U.S. educational system, she always provided support (Espinoza-Herold, 2007). When this student was missing classes due to a car accident, her mother and father rearranged their schedules to assist her and ensure that she would not give up. Her mother would say the following *dichos: "No te preocupes . . . ocúpate*" [Do not fret . . . get busy] (Espinoza-Herold, 2007, p. 270). *Dichos* continue to motivate and build resilience for Latinx students and also have the potential to support learning.

The use of linguistic resources such as *dichos, consejo*s (advice and counsel), and *adivinanzas* (out-of-the-box thinking) have been documented to support learning, particularly in STEM. These *dichos* include animals, plants, nature, and processes to metaphorically represent daily lives (Arreguín-Anderson & Ruiz-Escalante, 2018). *Dichos* have been used to support children not only in learning about life but also science through popular music, books, and TV shows such as *Como Dice el Dicho* ("As The Saying Goes," a Mexican drama series since 2011; Arreguín-Anderson & Ruiz-Escalante, 2018). Findings indicate that prospective teachers' background knowledge of traditional sayings, riddles, and tongue twisters of science is limited (Arreguín-Anderson & Ruiz-Escalante, 2018). Furthermore, culturally diverse families usually support literacy practices in the language in which they are most comfortable and proficient (Gándara, 1995). Therefore, leveraging these linguistic resources is a unique opportunity to engage in Latinas deeply and meaningfully in science and sense-making.

Bilingualism and Biculturalism in Everyday Language. In sum, biliteracy and bilingual research has found two ways in which Latinx students use language to support learning. The first is bilingualism and the use of Spanish for instructional resources and support via *chanza* or "Spanglish" (Bruna, 2007; LópezLeiva et al., 2013). Students who know Spanish are able to engage in higher order thinking skills in mathematics (Khisty, 1995) and cooperate and interact with other students in the classroom (Garcia, 1994). Written and verbal Spanish has also been used to legitimize the language and allow students to apply scientific vocabulary and ideas (Garza & Arreguín-Anderson, 2018). The second way language is used to support Latinx students is leveraging biculturalism through bilingualism. *Dichos, consejo*s (advice and counsel), and *adivinanzas* (out of the box thinking) support science learning (Arreguín-Anderson & Ruiz-Escalante, 2018). Leveraging language as a resource is an untapped opportunity for Latina students to engage in sense-making that draws on their linguistic assets.

Conceptualizing Language & STEM Meaning Making. Review of the concept of language use and bilingual education has indicated that bilingual students are able to use all meaning-making resources from various home languages and negotiate these resources in learning (Herrenkohl & Cornelius, 2013; Moll, Amanti, Neff, & Gonzalez, 2009). Language, when leveraged, can be an important resource that has potential to be a powerful identity resource. Despite its potential, how language can be leveraged as a resource for developing a STEM identity is currently under-studied and under-theorized. Therefore, I turn to the literature in bilingual education which applies cognitive perspectives (Valdés-Fallis, 1978) (e.g. code-switching) and social cultural perspectives (Nasir, Rosebery, Warren, & Lee, 2014) (e.g. translanguaging) to discuss language resource use in learning.

Cognitive Perspectives. From cognitive perspectives, bilingual students use language as a way of participating in and engaging with learning activities. Code-switching, defined as the alternative use of two languages on the word, phrase, clause, or sentence level, has been studied in supporting bilingual students' engagement in the classroom (Valdés-Fallis, 1978). There has been a common misunderstanding that switching from one language to another is a sign of deficiency. This deficit perspective is challenged in the literature. Using multiple languages has been found to support attention and participation in classrooms (LópezLeiva et al., 2013). Bilingual students are able to participate and overcome language barriers to interact with their peers and the course content (Brown & Souto-Manning, 2007). Further foundational pieces have found that success in learning experiences often encourages bilingual students to draw from multiple languages in different settings (e.g. home and out of school) to connect new concepts with their home resources (Moll et al., 2009). When bilingual students participate in using multiple languages, they are entering new ways of engaging and sharing meaning and making sense of the world (Schleppegrell, 2004).

It is important to understand how using multiple languages, such a code switching, supports bilingual students' learning of STEM. In doing so, educators and researchers can understand the types of intellectual work that bilingual students are participating in. In addition, it is also important to widen the analytic grain size of language to a social cultural perspective. In doing so, researchers and educators can understand language beyond mere speech and spoken words. Rather, studying language in a social cultural perspective allows us to understand meaning-making and connections from cultural resources to the disciplinary practices of STEM learning.

Sociocultural and Socio-Linguistic Perspectives. Widening our understanding of the work of multiple language use allows us to understand meaning making and therefore identity work. Moving to sociocultural perspectives allows us to focus on language as a cultural tool that mediates learning, cultural production, and change (Nasir et al., 2014). By doing so, language becomes part of the process of negotiations and social engagements in STEM learning. In other words, bilingual students are engaging in language that constructs knowledge, enacts relationships, and negotiates meaning (Herrenkohl & Cornelius, 2013). From a sociocultural perspective, leveraging language invites and welcomes home-based and out-of-school practices.

Translanguaging is the process of using meaning-making resources, from different languages, and making meaning in a new system (Hawkins & Mori, 2018). Previous literature has shown ways in which students engaged in translanguaging to engage in STEM meaning making. For example, in a chemistry class, students engaged in translanguaging when asking for help and engaging in conversation with each other when discussing the periodic table. The students engaged in brainstorming ideas of items made from the metals of the periodic table such as "*trazar tu llave* (my ugly keys)" (Poza, 2018, p. 14). In other words, learning of content and language is a situated practice that pays attention to linguistic social hierarchies and recognition of dominant discourses (Flores, 2013). In doing so, bilingual students' multiplicity of voices and identities are embedded in language rather than just utterances of sound (García & Wei, 2013). In doing so, bilingual students often are challenging language boundaries and developing new content knowledge and academic skills (Poza, 2018).

Drawing from Chicana feminist perspectives, Gloria Anzaldúa (1987) highlights the lives and language use of bilingual Chicanas. Language choice becomes a political act as a means of positioning themselves in relation to power (Ramsdell, 2004). Anzaldúa untangles language as access to power in her chapter "How to Tame a Wild Tongue." She describes creating a language "which they can connect their identities to, one capable of communicating the realities and values to themselves - a language with terms that are neither *español ni inglés* (Spanish or English), but both" (Anzaldúa, 1987, p. 55). Anzaldúa describes how she and other Chicanos are capable of communicating in many rich linguistic variations: Standard English, working class and Slang English, Standard Spanish, Standard Mexican Spanish, North Mexican Spanish dialect, Chicano Spanish, Tex-Mex, and *Pachuco (*called *calló*) (Anzaldúa, 1987, p. 55). Given this multiplicity of languages, many researchers have argued that drawing on students' knowledge and experience with language builds knowledge and competence (Groden, Kutz, & Zamel, 1993). It is important to think about the wide array of languages Mexican American girls can draw on as they engage with their different forms of meaning-making in identity work.

Summary of Findings

As a reminder, the specific questions that guided this literature review were: 1) What cultural resources and practices do Latinx students, particularly Latinas, leverage for their learning broadly, with a particular interest in science?, 2) From which settings do Latinx students draw their cultural resources?, 3) Who are the actors that may play a role in leveraging these resources?, and 4) What ways do other actors support Latinas and their learning? I will briefly summarize the answer to these questions using the literature I reviewed above.

Cultural Resources and Practices of Latinx. As described above in themes 2-4, the cultural resources and practices of Latinx students leveraged broadly for learning include: social networks and families (Theme 2), family and home resources (Theme 3), and linguistic resources (Theme 4). Social networks and families include *cuentos* (stories) and *consejos* (advice) to build resiliency (Kayumova et al., 2015). Family and home resources, particularly mothering pedagogies, include family traditions, beliefs, histories, values, cultural and personal literacies, and ways of knowing (Durand, 2011; Elenes et al., 2001; Urietta, 2007). Linguistic resources include c*hanza*s that can be used as a tool to learn STEM and represent a bilingual resource (Bruna, 2007; LópezLeiva et al., 2013).

Settings of Cultural Resources. As described in themes 1 and 2, the settings of these cultural resources primarily are in the home and community (Theme 2) and counter-spaces like after-school programs (Theme 1). Home and community settings provide important resources. These include mothering pedagogies (Durand, 2011; Elenes et al., 2001; Urietta, 2007) and barrio-based approaches (Irizarry & Raible, 2011). Secondly, counter-spaces are important places of meaning making in learning. After-school programs and informal learning environments afford opportunities for alternative experiences for students. These academic experiences are centered around students' home languages, communities, and funds of knowledge as instructional resources (Gutiérrez et al., 2011).

Actors Playing a Role in Leveraging Resources. As described in themes 1, 2, and 4, teachers and mothers play active roles in leveraging resources across settings. Informal and formal teachers can support Latinas in their learning. Pedagogically, teachers can support Latina students by engaging in students' informal literacy practices and assets to co-construct meanings of learning (Bruna, 2007; Valeras et al., 2014). Teachers can also leverage language in bilingual settings, to process higher order cognitive skills (Khisty, 1995) and allow cooperative group work (Garcia, 1994). Meanwhile, students' mothers are responsible for teaching and transmitting values and beliefs about the family and their cultural roots and heritage. Therefore, the mother becomes the central figure that daughters try to emulate (Espinoza-Herold, 2007).

Ways Actors Support Latinas and Learning. Mothers and teachers support Latinas and their learning through mother pedagogies (Theme 2) and barrio-based approaches (Theme 3) respectively. Mothering pedagogies are described as when Latina mothers, dedicated to their children's *educación,* enact family traditions, beliefs, values, cultural and personal literacies, and ways of knowing (Durand, 2011; Elenes et al., 2001; Urietta, 2007). Barrio-based approaches utilize culturally responsive pedagogies in learning environments that focuses on understand the social and cultural connections and networks within the Latinx community (Irizarry & Raible, 2011).

Conclusions and Gaps

I explored four themes in the literature of supporting Latinas in their academic success with a particular focus on literacy, science, and math. These themes revolve around counter-spaces, education and family, home pedagogies, and linguistic resources. From these four themes, I argue that Latinas draw on various cultural resources and practices, such as linguistic resources, from the home setting to succeed in learning, particularly science. In fact, these resources, particularly linguistic resources, emerge from a home and family pedagogy. Within this home and family pedagogy, *la educación* is central to *la familia* where students, with their cultural resources and histories, create counter-spaces against traditional schooling practices to succeed academically such as science, mathematics, and literacy. Yet, there is still an opportunity to learn more about the best ways to support Latinas in science.

There are two areas that still need to be addressed about Latinas academic engagement, particularly in science: intersectional approaches and a focus on science identity development. The literature that was reviewed primarily has drawn on Latinx communities broadly. Some have focused on Mexican American or Mexican descent families (16/36 articles reviewed = 44%) and some have not been specific (e.g. including other Latinx groups like Guatemalan or El Salvadorian). In order to not simplify and essentialize race, researchers need to disentangle race across the various ethnic groups. Moreover, gender is often not disentangled where the research literature does not differentiate between genders. Of the 36 articles reviewed, only 9 of the 36 articles, or 25% specifically, focus on Latinas. If we want to continue to address the problem of Latinas engagement in STEM, more literature must disentangle the intersectional identities of Latinas across gender and ethnic groups. Secondly, little research has focused solely on science identity of Latinas. In this literature review, 4 out of the 36, or 11% of the articles focus on Latinas development of science identities. The literature has developed and been strong regarding best ways to support Latinas in their academic engagement of science, mathematics, and literacy. It is therefore important to take what the research has shown us and connect it to the social practices of Latinas as they develop a science identity.

CHAPTER 3: THEORETICAL AND CONCEPTUAL FRAMEWORK

Generating Identity Resources through Leveraging and Recognizing Resources

Theoretical Framework: Social Practice Theory

This section will unpack the theoretical perspective of the present study and discuss how this perspective guides our research activities. The section continues with a description of the conception of identity resource, and a discussion on how to recognize it. The chapter concludes with a description of language use and a discussion of how language can be leveraged and recognized to be an identity resource.

Social Practice Theory, STEM Learning, and Identities.

This project draws on social practice theory (Holland, Lachicotte, Skinner, & Cain, 1998) to understand how STEM learners generate sense of selves in relation to STEM based on the local patterns of meaning around them (Calabrese Barton et al., 2013; Tan, Calabrese Barton, Kang, & O'Neill, 2013). Students who engage in learning activities creatively use resources to fashion new possibilities for making sense of and participating in a social world (Carlone, Haun-Frank, & Webb, 2011; Eisenhart, 2000). Students acquire cultural resources through participation and create shifts toward either reproduction of culture or production of new cultures (Carlone & Johnson, 2012). In other words, I view that STEM learning is a process of making meaning of STEM, forging relationships, and developing a sense of self (Tan et al., 2013). From a social theory perspective, identities are always shifting and therefore are hard to capture and measure. At any given point in time, we only see a snapshot of a person's identity. However, this snapshot does not offer a complete and sufficient representation of the negotiation of identity. As suggested by Calabrese Barton and her colleagues (2013), I use the notion of "identity work" to understand how, over time, a person develops an identity.

Grounded in a social practice theory perspective (Holland et al., 1998), I look at STEM identity resources through the lens of STEM identity development. The learning activities occur in after-school, school, home, and other settings. These figured worlds are socially and historically where "people come to conceptually (cognitively) and materially/ procedurally produce (perform) new self-understandings (identities)" (Urietta, 2007, p. 21). In other words, figured worlds are theoretical spaces where new identities are shaped and reshaped. In addition, I draw from activity theory (Cole & Engeström, 1997; Engeström, 2000) to systemically examine how Mexican-American girls engage in identity work in figured worlds. Activity theory draws my attention to the subject, object, outcome, rules and norms, community, division of labor, and mediating artifacts within the figured world and the processes of meaning making (Cole & Engeström, 1997; Engeström, 2000).

Identity Work. Identity work is defined as "the actions that individuals take and the relationships they form (and the resources they leverage to do so) at any given moment and as constrained by the historically, culturally, and socially legitimized norms, rules, and expectations that operate within the spaces in which such work takes place" (Calabrese Barton et al., 2013, p. 38). From this perspective, the development of an identity is viewed as an ongoing process of becoming. This process involves constant negotiations of meaning, positions, and contexts (Holland et al., 1998; Tan et al., 2013). A person's identity is based on the cultural resources and practices that are leveraged within a given time and space (Holland & Lave, 2009). These social, cultural and historical contexts either afford or constrain which resources are leveraged (Wortham, 2005). Using these resources leads to an altered sense of self (Calabrese Barton et al., 2013; Holland et al., 1998) and new ways of figuring out who one is (Urietta, 2007). In this study, I am interested in new ways of participating in STEM and supporting Mexican-American girls in forming a new sense of self in relation to STEM. I pay particular attention to the process in which leveraged and recognized cultural resources cultivate opportunities to develop a sense of self in STEM.

I also pay attention to identity artifacts, which are *both* products and processes of identity work, and describe how these girls leverage their resources and how their leveraged resources are socially recognized by others, if at all. I take on the idea that new identities are produced through identity artifacts which are assembled packages of mediated resources or identity kits (Gee, 2000). In applying the social practice theory of identity, these identity artifacts reflect the relationships and specific practices and positions of the students (Leander, 2002). Identity artifacts become reflections of practice and the meanings they take on (Holland et al., 1998; Wenger, 1998). Practices and discourses during identity work that shape an identity must be enacted and recognized (Gee, 2000). This recognition and positioning is a pivotal point in which social interactions shape identity (Holland & Leander, 2004). The process of positioning is not the only interaction that shapes identity. In fact, *being* positioned itself is identity shaping (Holland & Leander, 2004). In other words, being positioned is a process and a product of identity work and development.

Identity Artifacts. In this study, I examine identity artifacts and positioning as not just the *process* of identity work and development but also the *products* such as actions and objects. Previous literature has also shown the same where identity artifacts are both the *process* and *product* of identity work. For example, one student created a movie about energy efficiency and showed it to her peers (Calabrese Barton et al., 2013). As a product, the movie showcased ideas of energy efficiency. As a process, the student was able to highlight her science expertise and position in the school. In the present study, one of the case study girls, Ali, created a worksheet and quiz on engineering design and forest fires as a *product* of identity work. As a *process*, Ali created the worksheet to showcase her expertise in STEM, create a role for her group to participate after being bullied, and to challenge the power dynamics of the group as the expert in STEM. In other words, during identity work, I pay close attention to semiotics and the positioning of the girls as products of social interactions and their web of relations. In particular, my conceptual framework of identity resources, described below, builds off of the notion that identity resources are both a *process* and *product* of identity work.

In the process of identity work, identity artifacts are projected against social spaces where meaning is constructed in relation to the participant. Identity artifacts are not simply created by the participants, but the social space gives the participant grounds in producing identity artifacts (Leander, 2002). Students produce artifacts given the affordances and constraints of those spaces such as resources and power structures. Social spaces are not simply stagnant but are dynamic and produced through relations (Leander, 2002; Lefebvre, 1991). Therefore, we must pay attention to the production of space, such as identity artifacts, and not just the products of space.

Summary of Theoretical Framework.

Studying identity development should be shifted to not just how identity work takes place within space and time but rather how identity work takes place *across* different types of space and time. This shift in space helps researchers to understand the identity artifacts that are mediated across different spaces rather than within a single space (Lefebvre, 1991; Soja, 1989). The multiplicity of spaces has been described as shifting from intra-activity systems of relations to inter-activity systems of relations or polycontextual perspectives (Leander, 2002). This particular perspective highlights the multiple communities of practice and multiple identities as well as the complex practices that take place. Using a polycontexual perspective helps understand the resources that are parallel across contexts.

In this study, I examine the identity work that takes place across different types of space and time. Doing so requires close attention to multiple settings and different actors, resources, identity artifacts, and positioning that takes place in those settings. This project builds off the literature of multiplicity of settings and spaces to understand the multiple communities of practices that the participants engage in, not limited to traditional schooling. This project continues to build off not only the settings but also the actors and artifacts across the different settings involved in STEM identity development.

Conceptual Framework: Identity Resources

In an equity-related approach, an expansive view of culture, resources, and practices is taken. Cultural resources and practices are defined as youth's way of doing, being, and knowing when engaging in cultural activities (Gutiérrez & Rogoff, 2003). These everyday routines in practice include using mobile phones (Chan, Walker, & Gleaves, 2015) and gaming consoles such as the Wii, PS3, and Xbox (Gurung & Rutledge, 2014). Broadening the definition of resources as a cultural practice makes it possible to re-configure ways to broaden pathways for STEM engagement as connected to the lived experiences of youth.

It is well documented that leveraging non-traditional resources opens new opportunities for girls of color to engage in practices of STEM and develop a sense of self in STEM (Gonsalves, Rahm, & Carvalho, 2013; Thompson, 2014). Those resources are leveraged from various settings outside of school, such as students' homes, into learning activities both in school and after school (Schademan, 2010). This fluid perspective is different from that which views cultural resources and practices as a “concrete bounded world of beliefs and practices” (Sewell, 1999, p.39). Instead, cultural resources are fluid, constantly negotiated (Seiler, 2013), and produced and reproduced from systems of participants’ past experiences (Sewell, 1999). Resources and culture are neither static nor rigid. Instead, leveraged and recognized cultural resources are constantly being reproduced (Carlone & Johnson, 2012; Kane, 2011). Therefore, culture is not passed down from one generation to the next (Seiler, 2013) but rather, cultural practices and resources are leveraged and constantly negotiated with new meanings as students learn.

Conceptualizing Identity Resources

One goal of this study is to understand how certain recognized and leveraged resources in identity work create new meaning and how STEM identities emerge over time. Figure 3.1 illustrates the conceptual framework. Resources from one setting are leveraged and recognized in another setting (Schademan, 2010; Zimmerman, 2012), which leads to increases in engagement and shifts in sense of self in STEM (Carlone & Johnson, 2007). New meanings and shifts in identities that emerge as resources become identity resources. Prior studies suggest that generating identity resources involves two inter-related processes (Calabrese Barton & Tan, 2009; Carlone, Johnson, & Scott, 2015; Rahm & Moore, 2015). First, outside resources are leveraged during identity work. Next, the leveraged resources are socially recognized by someone, and at the same time legitimized in the moment, positioning the Latina as “capable” or “an expert.” The following further unpacks these two processes.

Leveraging Resources. Leveraging cultural resources and practice from a student’s lives has been documented in the literature. One example is students’ everyday practice of using smartphones. One participant of Chan, Walker, & Gleaves (2015) study, Stevie, recounts how

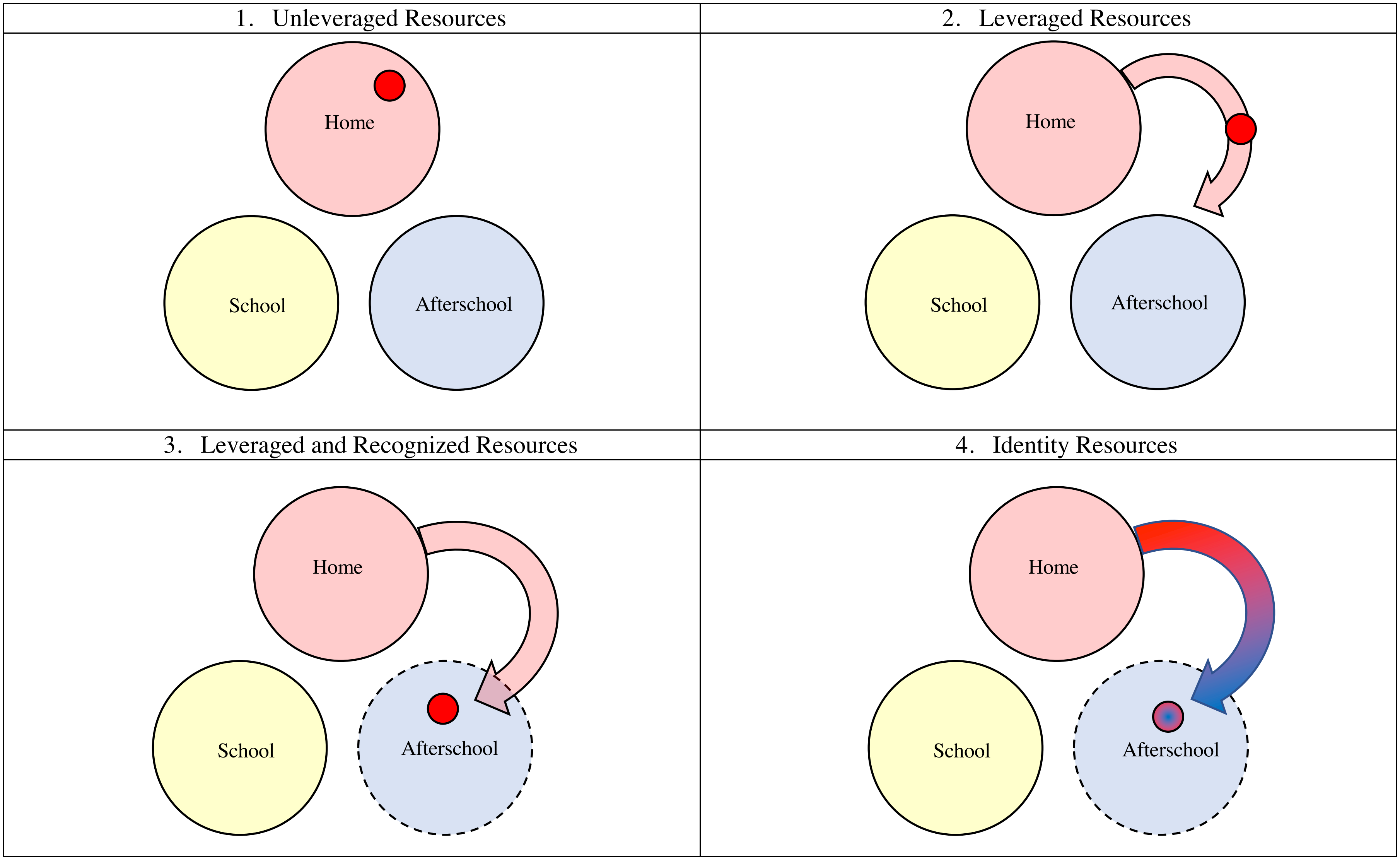


Figure 3.1. Conceptual Framework of Identity Resources

"the older generations tend to think if we're holding our phones, it means we're texting, we're not reading. What they don't know is that we might be reading through our smartphones" (p. 102). Smart phones are also cited as opportunities to engage in English language building, literacy practices, and eventually positive academic outcomes. In the same study, parents leveraged and recognized smartphone usage as a resource to learn. One parent purchased a smartphone for a younger sister, and then encouraged the younger sister to read on that device. Over time, smartphone resources would generate identity resources for the younger sister to see herself as a reader.

The first process highlights the outside resources that are leveraged by a person during identity work. Since everyone carries a history in their own social contexts, they may have multiple resources available to them (Tan & Calabrese Barton, 2008). By leveraging girls of colors' other resources, educators open many opportunities and pathways to acknowledge their multiple experiences (Calabrese Barton, Tan, & Rivet, 2008; Carlone et al., 2014). The first process calls for paying close attention to who these girls are both in and outside of school. The second process is recognition of the leveraged resources by others, such as peers and teachers.

The top two boxes of Figure 3.1 can be used to illustrate how resources are leveraged. In the top left box, Unleveraged Resources, the various resources from the settings of school, after-school, and home are unconnected and independent from one another. These cultural resources and practices exist in their own settings such as students' engaging in family-based practices like arts and crafts in the home setting. In the top left box, Leveraged Resources (i.e., the red dot) and the various resources from other settings are leveraged in other settings (Schademan, 2010; Zimmerman, 2012). For example, arts and crafts, a home-based resource, can be leveraged in a

STEM-based activity like creating dioramas in the after-school setting and as a result, home resources are leveraged in the afterschool setting.

Recognizing Resources. Recognition is a process by which one creates meaning with others who are participating in the practice (Davis & Singh, 2015; Zimmerman, 2012). Research increasingly highlights the critical role of recognition in ones' identity development (Carlone & Johnson, 2012; Kane, 2011). The resources that are leveraged from other settings and then recognized by meaningful others in the moment "carry multiple meanings both within and across contexts" such as the after-school STEM club and home (Schademan, 2010, p. 365). This emphasizes the importance of celebrating the girls' histories and experiences in facilitating their learning.

Prior studies indicate that a lack of leveraged and recognized identity resources decreases opportunities for girls of color to engage deeply and meaningfully in learning. For example, Diane, an African American girl, who was inquisitive and liked to explore nature, lost her interest and engagement in STEM-related activities over time (Calabrese Barton et al., 2013). Diane had won a model rocket competition the prior year. She received an A in her science classes, and actively participated in English class where she wrote poems and hip-hop songs. Despite an available wealth of cultural resources and practices, none of them were leveraged and recognized by her peers or her teacher when she engaged in STEM-related activities.

The bottom left box of Figure 3.1 illustrates how resources are recognized. In the bottom left box, Leveraged and Recognized Resources, the various resources from the settings of home are first leveraged and then recognized in the after-school setting. In the bottom left box, the boundaries of this setting are dashed to indicate the porous and flexible nature of these resources (Seiler, 2013) when leveraged and recognized resources enable new meaning-making in STEM activities (Carlone & Johnson, 2012; Kane, 2011). For example, home-based resources, such as arts and crafts, might be recognized by either a teacher or other students. As a result of this recognition work, the resource can be successfully leveraged and becomes part of the after-school setting.

Conceptual Framework: Identity Resources. In short, prior studies suggest that leveraging and recognizing Latinas' cultural resources and practices is crucial for girls' developing sense of selves in STEM. Adopting the conception of identity resources as the analytical lens for this project, I examine the two inter-related processes of generating identity resources—leveraging and recognizing—when Latina girls engage in STEM-related activities.

The bottom right box of Figure 3.1 illustrates how leveraged and recognized resources generate identity resources. The blue/red dot represents a generated identity resource – partially red to indicate the setting where it is leveraged and partially blue to indicate the setting in which it is recognized. As a result, the new resource is its own generated identity resource.

Summary of Conceptual Framework: Identity Resources

To summarize, prior studies suggest that developing a STEM identity and STEM meaning-making emerge from leveraging and recognizing cultural resources and practices from home and out-of-school experiences. One such resource and practice includes language. For the current study, the literature on language use sheds light on how this process might happen. The literature on language use helps to explicate the relationships that are negotiated and formed for bilingual Mexican-American girls. Using the concept of identity, I also looked at how language serves as an identity resources and acts as a bridge for STEM engagement. The concepts of identity resources guide the inquiry of the present study, including the research questions asked, data collection, and analysis.

CHAPTER 4: CONTEXT AND METHODS

A Critical Ethnographic Case Study Methodology: Highlighting What Equitable After-school STEM Looks like for Mexican-American Girls at Camino Brillantes Academy

Study Contexts

The School

Camino Brillantes Academy, a pseudonym, (a translation of Bright Paths Academy in Spanish) is a K-8 public charter school in the local Orange County area. Opened in 2001, *Camino Brillantes Academy* (CBA) serves 884 students, predominantly Hispanic/Latinx (95.4%), English Learners (50.6%), and socially and economically disadvantaged (72.3%). Unique features of CBA are that the school uses bilingual instruction (50% Spanish and 50% English), and has an onsite wellness center, parent resource center, and adult school. Unique to this study is that CBA organizes and implements its own after-school program with its own staff and curriculum using school funds, fees from parents, and After School Education & Safety (ASES) funding. Students with low academic performances are required to participate in small group academic interventions such as boosting reading and math abilities. The second group of students are those not designated as needing academic interventions. These students participate in organized enrichment activities such as *baile folklorico*, music, drama, chess, and STEM (the after-school program for this study).

There are 4 main buildings to CBA across 3 areas. The first area is called the elementary school side. It contains a two-story building, portables, and a playground. The two-story building was the first of the permanent structures of CBA. The middle school side was under construction during the time of data collection, so all 6th-8th graders were relocated to the elementary school side. Outside of the school, but within the same block, were two converted Victorian houses. The first one, called the White House, serves as a multipurpose area. The White House is used for school pictures, assemblies, and also recently raised enough money for a STEM maker space. The next building off of the main campus houses the administrative offices and supply area for the school. Right below the administrative offices is a food pantry called CBA Mercado.

During the time of data collection, CBA was going through a major construction shift with multiple phases. Often described as “the CBA way,” organized chaos was appreciated and embraced. There were multiple moving parts to the school in terms of staff, leadership, and programs. The school was “constantly expanding and growing and more and more were added on people’s plates” according to many of the teachers and staff. Many of the structures were portable classrooms. However, through a three-year expansion, the school secured enough money to be able to build three new buildings. Because of this, many buildings changed throughout the year and people and students had to constantly find the new location of things that were previously located.

However, through the chaos, multiple partnerships across UCI and the community were formed with CBA including the nursing program and other STEM departments at UCI. Additionally, CBA collaborated with many community organizations that offered programs on-site or referred them to other programs. These community programs included various arts, STEM, and cultural programs. As part of this project, my advisor and I were also invited to the school’s end of year fundraiser gala on 5/19/18 as guests of the school.

As part of the bilingual curriculum and culture of CBA, Spanish is embraced and integrated into the curriculum. When students start at the kindergarten level, instruction in the school is 90% Spanish and 10% English. After that, each grade level decreases Spanish instruction by 10% and increases English instruction by 10%. At the 5th-grade level and above, Spanish is 50% and English is at 50%. However, courses are not evenly divided in Spanish use. At the 5th-grade level and above, English Language Arts, Social Studies/History, and Science are taught in English while Math, Physical Education, and Spanish are taught in Spanish to achieve the 50/50 requirement. However, students are also allowed to speak Spanish in Science and there are times when Spanish is used for a few phrases in science instruction. During math instruction, students are expected to respond to and ask questions in Spanish. When the students used English, they are asked to use Spanish. For students who are not familiar with Spanish, other students will translate in English for them. On the playground, the lunch area, and in the hallways, Spanish is used to communicate between teachers, office staff, lunch proctors, cross guards, and students.

As part of the day-to-day routines in the school day, students sat in groups for a majority of their classes. To start off instruction, teachers would provide announcements, ask students to turn in their homework, and announce the new lesson for the day. As part of the math curriculum, worksheets and manipulatives were often used. The word problems on the worksheets were written in Spanish and students were expected to read the word problems and respond in Spanish both verbally and written on their worksheets.

In the school setting, many science activities were typical and ranged from worksheets, to group activities, to project based activities. For example, one of the science activities during the ecosystem unit was to recreate and conduct research on a flower and create a model. Students were asked to conduct background research, create outlines, type out responses to questions, print out the responses, and paste it on their model of a flower. Many of the science activities were based on memorization, conducting online research about a phenomenon, and worksheet-based. However, as the years have gone by, many of the activities in the science classroom focused more on the lived experiences of the students. For example, a year after this study, for the electricity unit, science teachers asked students to design a taco truck model and include working lights for the signs of their taco truck model.

After-School Setting

The classroom during the school day belonged to Ms. Perez, who has been the middle school science teacher at CBA for the last 11 years. Ms. Perez, a Latina teacher, completed her undergraduate work at UCLA and a Master's program in Bilingual Education. She has close relationships with NASA and JPL and is a NASA certified lunar and meteorite instructor. She is the co-founder of the Science Beyond Books program in collaboration with JPL and CalTeach. Ms. Perez consistently organized extracurricular activities, including a *Latinx in Astrophysics* monthly club meeting and field trips to watch space launches like the one in Santa Barbara. Whenever our research team would come to teach, she informed us about future upcoming events related to space exploration. She often handed the researchers fliers and shared these opportunities that she was a part of at school and in the local community.

The classroom reflects Ms. Perez's personal interest in and commitment to astrophysics and astronomy. Her classroom was decorated with telescopes, solar system models, images of space, galaxies, and even had student work of constellations pinned to the ceiling. The classroom tables were all round, with 6-7 chairs around each table. This arrangement of tables enabled opportunities for students to engage in group work. All of the students face each other at all times. In the center of the classroom is a "teacher's table" that includes access to the projector and necessary cables. In the back of the classroom were a row of desktop computers. Long white boards were located on the other wall.

Ms. Paloma, a Latina teacher and sister to Ms. Perez, is the main after-school staff member who works with the UCI team. She is always looking for ways to ensure that we are able to engage in our work as smoothly as possible. Ms. Paloma teaches a school-wide robotics class during the day. In the after-school session, she usually teaches science. When she is with us, Ms. Paloma usually stays behind at the teacher's desk engaging in catch-up work. Once in a while, Ms. Paloma floats and checks on the progress of the students. Otherwise, Ms. Paloma is quite "hands off" and is only a part of the after-school activities for logistical and emergency purposes, such as parent questions and finding the students' next activities if they have an early dismissal. When we are not teaching at the after-school program during finals weeks and breaks, Ms. Paloma usually leads the pre-developed curriculum that the school has provided.

The after-school program, organized by CBA, had many other activities. These ranged from chess club and sports to music and *folklorico*. To start off the after-school time, students line up outside on the playground. Role is taken and students are provided with an afternoon snack. Typically, students participate in two blocks of instruction – about fifty minutes each. In between each block, they would participate in recess for fifteen minutes. After the two blocks of instruction, students complete their homework until they are picked up from the after-school program.

In the after-school setting, English was primarily used for science instruction. The entire curriculum was written by undergraduate research assistants. Students were encouraged to use both English and Spanish. The undergraduate research assistants who could speak Spanish did so whenever they felt like they needed it, such as during teaching, providing instructions for large groups, and conversations in group work. Students are also able to converse in both English and in Spanish during the after-school time. This could be to respond to questions and prompts posed by the teachers, when presenting their projects such as posters and show–and-tell, and also during day-to-day conversations about hobbies and family life during group activities.

As part of the routines in the after-school setting, there were clear intentions to challenge traditional norms of what learning is and how people learn. For example, the learning environment of the after-school setting was organized to challenge narratives of school learning. Students were able to address everyone on the UCI team on a first name basis. Students were not expected to formally call the educators *maestra/o* (teacher) like they would typically address their classroom teachers. The curriculum was designed on quarterly projects that built on each week rather than focus on one single activity in a disconnected session. The first few weeks of the quarter was built around content knowledge and research. The last half of the quarterly projects was producing some sort of artifact that they can share. Students were freely able to walk around between groups during work time. Otherwise, during group discussions, students were expected to participate in the group; either standing or sitting. Students had access to the unblocked Wi-Fi on the iPads we provided (unlike the protected Wi-Fi at school). They were able to play music from the iPads if they wanted to as long as it was not distracting. Students had access to power tools and other learning tools that are not typically seen in school environments. Each team was assigned a UCI educator to work with them throughout the projects. The students were able to ask their UCI educators for help. Since this was an after-school program, students were able to discuss pop cultural references such as music and memes and other youth culture such as Fortnite during their 15-minute break.

The After-School Curriculum. Each weekly visit was scheduled to be a total of two hours including a fifteen-minute break in between. The curriculum was designed quarter-by-quarter and was paralleled topically to the school day per the request of the Director of

Curriculum. The first fall quarter project focused on Energy. Students would break into groups to learn about various forms of energy and how they are related to students' everyday lives. Their final culminating project was to create some sort of media project about energy and how to eat healthier. The second winter quarter project focused on Ecosystems. Students would create a video documentary in groups to describe an ecosystem that they are a part of. They would storyboard, make props, film, and edit. The final spring quarter project focused on Engineering Design. Drawing from their Ecosystem videos, students had to be able to find a problem in their ecosystem and create some sort of solution. They had to create a draft, build a prototype, and test it to improve it. After each quarterly project students presented their final projects to the classroom.

As part of the curriculum development, there were clear intentions to challenge traditional norms and expectations of what STEM learning and science are. For example, the curriculum was organized around one big science idea that connected to the students. In groups, students were asked to think about how their projects may impact their daily lives. Furthermore, rather than focus on knowledge consumption, the curriculum was designed around producing and using science knowledge. There was also a heavy emphasis on scientific practices where students were able to engage in argumentation using evidence and communicate information. Furthermore, there was an emphasis on reflections of STEM through the *Science Show and Tell* and the *Science and Me* projects. During *Science Show and Tell*, students were able to showcase their STEM practices and forms of engagement from home. During the *Science and Me* projects, students were able to reflect on their previous, current, and future participation in STEM.

Participants. The after-school program for this study is a two-hour-long weekly after-school STEM program. CBA calls their after-school program "Extended Day" and believes that the after-school setting should be an extension of in-school goals. Students in Extended Day are divided into two groups: intervention and enrichment. Students who participate in intervention are performing below grade level at school. Students in Extended Day intervention participate in a mandatory after-school program meant to boost academic achievement. Intervention students only receive homework help, math support, and literacy support. Students who are performing either at or above grade level in school are eligible to participate in the enrichment program which includes science and chess club. Therefore, the participants in the after-school STEM club are only students performing at or above grade level as determined by CBA. Though the case study girls are performing at or above grade level, this study is interested in the STEM identity development and not the STEM academic achievements of these case study girls. This study is interested in the on-going STEM identity work which occurs regardless of academic achievement and tracking in schools.

A total of fifteen 5th graders have participated in the after-school program including the four Mexican-American girls discussed here. There were ten boys, all but one of whom was Latino. Pedro, one of the 5th-grade Mexican-American boys, was in the case study girls' groups all year long. There was one other girl in the after-school program who is white and therefore not within the scope of this study. The students participate in an activity for one hour, have a break for about fifteen minutes, continue the activity for one more hour, and are picked up by their respective adults and caregivers. A team of UCI undergraduate students with supervision have written and taught STEM lessons and activities as part of this program. The after-school STEM program and curriculum is required to be parallel with the Next Generation Science Standards (NGSS Lead States, 2013) as it is part of CBA's Extended Day goals and mission.

School Community Context.

Family Science Night. During the school year, I offered to co-host a Family Science Night for the elementary school and middle school. The undergraduate students prepared the proposal and materials for this event. Family Science Night was an opportunity to engage with students outside of our after-school program and across grade levels. The event centered around building a robot drone and flying and testing it through an obstacle course. Family Science Night became an opportunity to be able to meet and informally interview the participants' family members. It was also an opportunity to interact and learn more about the participants through the different perspectives of the family members.

Science Camp. Every year, the 5th graders in winter or spring spend a week in Lake Arrowhead for science camp. Mr. Hernandez, one of the 5th grade science teachers, works with a committee of parents to organize parent volunteers who support logistics. The science camp is organized by an outdoor science school and provides the students with lodging, meals, and science activities including night hikes. Students stayed overnight in the camp and discussed their experiences during their first week back in the after-school program.

CBA Mercado. The CBA Mercado is a food pantry on-site at the school that is sponsored by a local food bank. Open to the community, the pantry provides healthy and nutritious foods available to all. The *Mercado* (Spanish for "market") acts differently than a food pantry where "instead of handed pre bagged and selected items, visitors make an appointment to shop and take food and basic necessities." This is important because rather than feeling like a food bank, CBA Mercado provides the experience of a grocery store. This offers the customers, rather than users, of CBA Mercado opportunities to make choices and have the same experiences with food selection as if they were paying for it. The entire Mercado is operated on a volunteer basis which primarily includes community members. Though the Mercado was operated on the

CBA campus, all but one of the after-school classroom students had visited CBA Mercado. One case study student, Maz, volunteers regularly with her father in running the daily operations and logistics of CBA Mercado.

School/Community Resources. CBA also has an on-site parent resource center and health center. The parent resource center is a space where parents are able to use computers and printers. There are also opportunities for parents to participate in various workshops held at the school on a variety of topics related to education and parenting. Meanwhile, the community health wellness center offers all forms of patient care for those with and without health insurance.

Educators

The educators of the after-school program were comprised mainly of undergraduate students acting as research assistants. The undergraduate students supported data collection by setting up the cameras in the classroom and assisting in assenting and consenting participants. Furthermore, the research assistants supported the execution of the program by editing and writing curricula and teaching on a weekly basis. In addition, undergraduates volunteered approximately two hours per week during the school day to assist with the day-to-day in-school instruction. This included grading, assisting with making posters and photocopies, sitting in small groups with the students to facilitate activities, and working one-on-one with struggling students. Since this study adopts the lens of social practice theory, it is important to focus on other key actors, such as the undergraduate students who assumed the role of teacher in the after-school setting. The analysis takes into account how the cultural histories of the educators are a part of the recognition and positioning of the case study girls during their on-going identity work.

Alondra. During the study, Alondra was a first generation 3rd-year undergraduate student who was majoring in education sciences. Alondra was previously a Political Science major and was interested in politics and how political systems worked. Alondra grew up in Riverside, California, in a predominately Hispanic and Mexican-American community. She values her family which is her primary support system. She has a little brother and a little sister whom she loves and supports. Alondra frequently goes back home to Riverside on the weekend to see her family.

Alondra has been volunteering at her church since she was young, supporting younger children and acting as a caretaker. She has volunteered with several after-school programs at UCI. At the time of this study, Alondra had already volunteered at CBA in the after-school program and classrooms for one year. As part of the research team, Alondra acts as a translator and cultural interpreter for the research team, talking to parents and students in Spanish. Moreover, Alondra has conducted undergraduate research with the video data collected as part of this project, studying student behavioral engagement in group settings. Alondra has also taken courses at UCI focused on bilingual education. When Alondra graduates from UCI, she plans to become a special education teacher and possibly pursue a teaching credential in bilingual education.

Lulu. At the time of the study, Lulu was a 4th-year first-generation undergraduate student majoring in public health policy. Lulu is from Perris, California, a predominately Hispanic and Mexican-American community. She originally grew up in Santa Ana before moving to Perris. She also has a little brother whom she supports. For example, when they go to Mexico to visit their grandmother, Lulu tells her brother to only use Spanish. Otherwise, locals may find out they are American and try to kidnap them and hold them for ransom. This is because many people outside of the United States believe that Americans are extremely wealthy. Lulu often describes the sacrifices of her family and how she feels so privileged to be able to go to pursue a college degree. She often states that her parents "work in the fields with their hands so that [she] can work with her mind."

Lulu has served in various customer service positions. She has worked at the local Chipotle down at the town center. After graduation, she worked as a bilingual research assistant at the Memory Impairment and Neurological Disorders (MIND) Institute and as a bank teller. As part of the research team, Lulu also acts as a translator and cultural interpreter for talking to parents and students in Spanish. At the moment, Lulu is pursuing work in customer service and research. Lulu is also heavily interested in Korean pop (i.e., K-pop) and is an avid fan of anime and Japanese culture.

Tessa. During the study, Tessa was a 3rd year public health policy and education student. Tessa identifies her ethnic background as both Filipino and Argentinean. Although she is not a native Spanish speaker, Tessa has some ability to understand verbal Spanish and has a high school diploma in bi-literacy. A native of Oakland, California, Tessa's mom is a middle school teacher. Tessa's beliefs are grounded in critical and feminist philosophies. As part of her academic work, she sees the importance of community health in order to support healthy communities. In her research, Tessa believes in understanding the social construction of health rather than the biomedical perspectives of health.

In her work, Tessa has acted as a camp counselor for a summer camp back in the Bay area. She has also volunteered in her mother's classroom back in Oakland. Tessa is active in her school community, acting as a leader in her sorority and Greek Life. Furthermore, Tessa has continued to help analyze, code, and transcribe the video data from the present project.

Other Educators. There were other people involved in the collection of this data. Carlos, a 3rd-year undergraduate biology major, assisted with the teaching of the after-school program during the fall quarter. Dr. Kasim Yildirim, a visiting scholar from Turkey, was also involved in the after-school program during the spring. Debbie, a 3rd- year education major, assisted with the transcription and analysis of the data. Ash, a third-year education major and native Spanish speaker, assisted with the transcription and analysis after data collection. Three additional undergraduate research assistants, Algrae, Vanessa, and Pamela, helped with planning Family Science Night although they did not participate in the after-school program.

Methodology

This study employed a critical ethnographic case study approach that leveraged the strengths of both critical ethnography (Carspecken & Walford, 2001; Thomas, 1993) and ethnographic case study approaches (Yin, 2013). The following provides a description of both case study approach and a critical ethnography individually highlighting its affordances in examining Latina's identity development. In this section, I describe how critical ethnographic case study approach is used in the project. This section concludes with a discussion about how to ensure the trustworthiness of the findings.

Critical Ethnography

A critical ethnography is defined as "a conventional ethnography with a political purpose" (Thomas, 1993, p. 4). My critical epistemology lends itself to a critical methodology, such as critical ethnography (Carspecken, 1996), in exploring Mexican-American girls' STEM identity development. As a critical researcher, I think about the multiple ways in which the phenomenon of Mexican-American girls' STEM identity development and resources is a representation of power relations and operates on who is recognized and who is afforded opportunities for STEM identity development (Carspecken, 1996).

With a critical ethnography, I used an ethnographic research approach to generate rich and thick descriptions with aims for social change (Tricoglus, 2001). The aim of critical ethnography is to aid in “emancipatory goals and to negate the repressive influences that lead to unnecessary social domination” (Thomas, 1993, p. 4). The emancipatory goal of my research is to shift how Mexican-American girls use education to empower themselves and their communities. Given the current political and social discourses and policies of 2017-2019, the goal of this research is to challenge the social inequities of socially, linguistically, ethnically diverse children, immigrants, peoples, and communities.

My research is political and transformative as it focuses on “what could be” instead of “what is” (Madison, 2004, p. 5). In other words, my research does not merely describe the present state of STEM identity for Mexican-American girls. Instead, this research offers both theory and practice of imagining “what could be” ways to support Mexican-American girls in developing identities in STEM, to transform systems of inequity, and to use STEM to improve the community.

Ethnographic Case Study

A case study is defined as a methodology that “investigates a contemporary phenomenon in depth and within real world context where the boundaries between phenomenon and contexts may not be clearly evident (Yin, 2013, p. 16). In other words, a case study attempts to understand a phenomenon that is occurring within contexts. In the case of the present study, the STEM identity development of Mexican-American girls is bounded within real-world context. But the context from setting to setting needs to be parsed out using identity resources as a theoretical lens. Other justifications of using a case study are 1) how and why questions, 2) inability to control behavior of the participants, 3) desire to understand the complexity of STEM identity development, and 4) the bounded phenomenon of Mexican-American girls identity development in STEM (Merriam, 1988). Ethnographic case study was utilized to describe and analyze the phenomenon of Mexican-American girls' STEM identity development using rich and thick descriptions (Merriam, 1988) from the critical ethnography.

Methodology: Critical Ethnographic Case Study

I define a critical ethnographic case study as a methodology that aims to transform social inequities by using rich ethnographic data to understand a real-world phenomenon and reporting cases of participants' transformations. To answer the two research questions, I used a critical ethnographic case study to describe the identity development of the Mexican-American girls. Using a critical ethnography generated rich and thick descriptions of how the Mexican-American girls identify with STEM across settings. Constant comparative methods were used (Glaser & Strauss, 1967) to analyze the resources and STEM identity development across settings. Cases are identified in which identity resources were generated. I then analyzed the shifts in STEM identity within each case. After developing my cases and an understanding of how their identities shifted, I then compared *across* cases to understand within which conditions STEM identity work was supported. Conducting a critical ethnographic case study allowed me to capture *who* is engaging (who else is within the community), *what* they are engaging with (object of the work and artifacts), *where* they are engaging (the setting), and *how* they are engaging (rules and norms and division of labor) during STEM activities.

Data Sources

Data generated aim to 1) document how Mexican-American girls engage in STEM across different settings, and 2) describe the process of how Mexican-American girls engage in STEM using language. Both qualitative (observation, interview) and quantitative (identity survey) data were collected as I collaborated with the four case study girls over a nine-month period (September 2017 – June 2018) across settings.

Videos and Field Notes

Video and field notes (see Appendix B: Protocol 2) of STEM activities were completed across settings. The four Mexican-American case study girls' identity work in STEM activities across settings were documented using video recording and field notes. The purpose of this is to understand the identity work in settings, what resources could be leveraged in STEM learning, how language was leveraged, and the practices of CBA as an institution.

School Settings. Every week, five to seven undergraduate research assistants would go to the school during the day to volunteer in classrooms. Over twenty-nine visits were made and they lasted approximately two hours each. Undergraduate research assistants took photos of student-produced artifacts on the walls as well as video recorded lessons across Math, Science, English, Social Studies, and Spanish courses.

After-School Setting. In the after-school setting, an iPad was placed in the back of the room to capture the daily routines, activities, roles, and tools used. A 360-degree camera was set up in the center of the tables during group work to capture a closer video of students when they engaged in the after-school program. Field notes supplemented any missing videos. I collected these data while undergraduate research assistants were teaching the after-school STEM program. These data were collected weekly for twenty-five weeks during the after-school program. A typical recording lasts two hours. The project generated around fifty hours of video data in the after-school setting. I also engaged in informal conversations with families while the girls were being picked up from the afterschool program on 2/15/17. During these conversations, I asked the parents about technology use at home while permission slips were signed. I was able to talk to Ali's and Ella's parents. Lulu was able to talk to Maz's parents.

Home Setting. In the home setting, a video-log recording (see Appendix B: Protocol 5) of the Mexican-American girls' everyday routines, activities, roles, and tools were created by the students. Students were prompted to take videos and pictures of 1) STEM in their daily lives, 2) the people that are important to them, and 3) their typical routines. I provided the prompts and instructions to the case study girls as the iPad lock screen. Each day had different prompts such as "Please record or take a picture of something that you think makes you unique. How does it make you unique?" and "What kind of activities do you do with your family on the weekends? Is there any science involved?" The case study girls filmed one week of home videos. After they returned the iPads, I interviewed the girls about these home diaries. The home video recordings portrayed one week of the girls' home toward the end of the study's data collection. The amount of data generated depended on how often participating girls used the iPad for photos, videos, and notes. These home video logs were also used as artifacts during interviews to discuss home-based practices.

Family STEM Night. In community events settings at the school, such as Family STEM Night, field notes were taken of students engaging with their families. The Family Science Night was an opportunity to speak with the family members of the case study girls and to learn more about their home practices. I primarily generated the field notes with assistance from Spanish-speaking undergraduate research assistants. The event lasted two hours in total. The amount of data collected was determined by when the family members of the participating girls showed up to the event. I hosted one Family STEM Night in March 2018 where the case study girls participated. Family STEM Night followed when the case study girls were picked up from the after-school program so that families could immediately attend the event. In order to minimize potential invasion of privacy, I introduced myself to the family members and the case study girls. I observed, participated, and informally interviewed family members through these conversations. All but one of the case study girls, Ali, participated in Family Science Night. My advisor and I were able to sit down at one of the activity stations with Zoe, her mother, and her older sister to engage in an informal conversation. My advisor and I also were able to stand in line and have an informal conversation with Ella and her mom. The conversation topics included the case study girls' participation and interest in science, home-based activities, and more information about participating girls' parents. Maz said that her and her family attended but we were unable to find her.

Open House. On May 17, 2018, I attended CBA's open house and showcased some of the video projects that the students worked on in the after-school program. I had a table right outside the 5th-grade classrooms and displayed the video artifacts, student-produced artifacts like posters, and photos of the after-school program. During this time, I was able to informally interview Maz's mother and father and meet her twin little sisters. I was also able to interact with other students in the after-school program. Additionally, I was able to visit classrooms and take photos of student-produced artifacts across different subjects. This included students' dream job board, ecosystem project for science, and Spanish essays about their family.

Netnography

I video recorded a netnography of any third/virtual setting that the student may be a part of. Netnographies are ethnographies that examine online cultures connecting virtual realms to real life activities (Kozinets, 2010). These might include online forums, online texting, gaming, and YouTube channels. The purpose of this examination is to understand the identity work of these virtual settings, what resources could be leveraged in STEM learning, the language use in each setting, and the practices of each third/virtual setting. I then conducted the video netnography with the Mexican-American girls. I asked about how these Mexican-American girls interact in these spaces. If a student expressed involvement in a third/virtual setting, I then asked them to engage in netnography with me. Each netnography lasted about half an hour with each case study girl. These virtual settings included the BTS Army Amino app (i.e., the fan page for the K-pop group BTS), YouTube, and Snapchat. This netnography occurred during the break of the after-school STEM program. I brought my laptop out and my phone and audio recorded and screenshot the various virtual settings. I then asked the case study girls to show me on my devices how they navigate through these virtual settings and copied the links to any websites they visited. At a later time, I reviewed these to learn more about each virtual space.

Surveys

The purpose of collecting these data is to capture an overarching snapshot of who the Mexican-American girls are *in the moment*. The survey (see Appendix B: Protocol 1) also provided an opportunity to expand on any responses during the interview. With the Mexican-American girls, two twenty-minute identity surveys were administered. The survey items included attitudes and beliefs about STEM, recognition in STEM, and how students see their future selves in STEM drawing from a previously validated survey, titled "Is Science Me?" (Aschbacher, Ing, & Tsai, 2014; Aschbacher, Li, & Roth, 2009; Kang et al., 2019). The undergraduate research assistants and I administered the identity survey twice, once at the beginning of data collection (12/6/18) and then at the end (6/1/18) of data collection. The identity survey was administered in the classroom during the school day. I negotiated with the teachers to determine the best time to administer these pen-and-paper surveys. I also used these surveys as artifacts during the interview to discuss home-based practices.

Artifacts

I collected two types of artifacts: 1) student-produced artifacts (identity artifacts) that are created by the students and 2) artifacts from the school environment. Identity artifacts were gathered from school, after-school, and other settings to include anything produced by the student. I also asked students to create digital stories of themselves and STEM. To bring even more of the resources from the home setting, I asked the students in the after-school program to bring a home STEM identity artifact for show-and-tell (Riojas-Cortez et al., 2008). Undergraduate research assistants and I collected identity artifacts in the after-school program and during the school day. Digital stories were generated once at the beginning and end of data collection. Identity artifacts from school and after school were collected following each activity. Identity artifacts may be collected across various settings. Any identity artifact that could be taken were collected with permission from the Mexican-American case study girls. Otherwise, a video or photograph of the identity artifact was taken. The prompt for the digital stories would be "tell a story of how you see STEM in your everyday life." I then asked the students to, in collaboration with their parents, identify an artifact that represents their family. I asked these students to bring the object to the after-school program and participate in a show-and-tell activity.

Attending to identity artifacts helps recognize how, during identity work, identities are stabilized or destabilized. Drawing from sociocultural theory and activity theory, cultural tools and artifacts that people engage and use as they participate in an activity that mediates learning and development (Engeström, 2000; Nasir & Hand, 2006). Identity artifacts can take on myriad forms including tangible artifacts and semiotic artifacts. Artifacts, which are also known as semiotic markers, of STEM can include symbols, formulas, and gestures that mediate an individual's relationships to the setting (Lemke, 1991). These artifacts show how students position themselves in the activity system in relation to the identity work at hand.

The final artifacts are those of the school environment. Artifacts of the school were collected to contextualize the learning environment. These also helped me understand what other events Mexican-American girls may participate in as well as some of the values of CBA. These artifacts include flyers that are normally in the front of the office, photos of the classroom and posters, newsletters from CBA, and lesson plans for the after-school program and school day. Undergraduate research assistants took photos of the classrooms. Undergraduate research assistants took photos of classrooms once a week. School artifacts were collected at school. Any artifacts that could be physically collected were taken and filed. Anything electronic sent by email were placed in a folder and saved as a PDF. All other artifacts were collected as photographs.

Interviews

Case Study Girls. I conducted two interviews (see Appendix B: Protocol 3) with each case study girl lasting between half an hour to an hour each toward the end of the year. Students were asked about their attitudes and experiences with STEM, how they position themselves in STEM, a memorable STEM activity, how they are recognized for their achievements, current and future senses of self, reflections on the after-school program, and home-based science practices. Recorded interviews with the Mexican-American case study girls were individual. I interviewed 5th-grade Mexican-American girls in the after-school program. Interviews were conducted at the end of the project. These interviews are not meant to evaluate the after-school program but instead identify shifts, if any, in STEM identity. These shifts from baseline to the second interview bookends the more substantive analysis from video recordings and field notes capturing STEM activities across settings. I used a semi-structured interview protocol piloted for this study. One focus of the interview is how other actors and languages have supported students' STEM identity development. During the interviews, I also used identity artifacts and surveys. These interviews helped me to understand how the Mexican-American girls position themselves and the nature of the resources that they leverage in their STEM identity development. I interviewed Ali on 4/26/18, 5/3/18, and 5/31/18. I interviewed Ella on 5/10/18 and 5/31/18. I interviewed Maz on 5/24/18. I interviewed Zoe on 5/31/18 and 6/7/18. Each interview lasted from half an hour to forty-five minutes.

Teachers. Semi structured interviews (see Appendix B: Protocol 4) with the teacher were conducted with teacher pairs. I interviewed the science and math teachers on 11/6/17 and 3/21/18. I interviewed the social studies, Spanish and English teachers on 11/13/17 and 4/13/18. Each interview lasted two hours. One focus of the interview is on how teachers support the Mexican-American girls' sense of self in their classroom. The second focus is on how teachers aim to connect with the lives of students when they teach. These interviews helped me understand how the teachers position and recognize the Mexican-American girls and the nature of the school setting and STEM identity development.

Data Analysis

I engaged in inductive and deductive coding iteratively while generating and revising the coding scheme from both the literature and the data. The theoretical framework of social practice theory guided my analysis where I looked at how individuals and groups are formed in cultural practice within larger sociocultural and historical structures (Holland et al., 1998). I worked with undergraduate research assistants, Alondra, Ash, Debbie, and Tessa to prepare the data and generate the initial coding. For data in Spanish, I asked Alondra and Ash, native Spanish speakers, to translate and code the data with me. I met with my advisor, a science education researcher, regularly to discuss findings throughout the process. My participants had a stake in the data analysis through member checks and debriefs. Data analysis included the use of inductive, abductive, retroductive, and deductive reasoning (Saldaña, 2014), constant comparative methods approach (Glaser & Strauss, 1967), and critial ethnographic case study.

The research explicates the process of how Mexican-American girls generate identity resources during identity work across different settings of home, school, and after-school settings. The unit of analysis is a Critical Event (CE) from a social practice theory perspective (Holland et al., 1998) to understand the shifts of identity during identity work and the resources leveraged in this work. I define a Critical Event (CE) as an event where there occurs any shift in participation of STEM engagement, emergence of identity artifacts, resources from other settings being leveraged, leveraged resources being recognized, and leveraged resources not being recognized (a missed opportunity). Relevant data sources include interviews with teachers and the Mexican-American case study girls, videos from the after-school setting, photos of school activities, home video logs, field notes from family STEM nights, and other artifacts.

First, all video data were first watched, and content logs were created summarizing the main events, activities, and interactions. I paid close attention to the activity system while describing the tools, rules/norms, division of labor, community, artifacts, and learning outcomes (see Table 4.1) This included a running description of the entire sequence of events, Spanish use, description of who is talking and responding, paraphrasing of discourse, and time stamps. This descriptive content log was generated from May 2017-December 2018 and yielded 258 single spaced pages of content logs. Undergraduate research assistants aided in this process. From September 2018-April 2019, Ash, a native Spanish speaking undergraduate research assistant, watched all videos and directly transcribed any spoken Spanish.

Second, to analyze the data, I, along with the undergraduate research assistants, identified Interesting Events. Interesting Events are defined as moments that caught our attention, language use, changes in participation, insightful comments/conversation from the case study girls, new artifacts produced from the activity, *dichos* that were used, when students are recognized, and when students mentioned connections to their out of school lives and routines. Interesting events were generated from September 2017- February 2019 and yielded 324 Interesting Events.

Third, after identifying Interesting Events, I engaged in the coding process using my guiding questions. To ensure theoretically and conceptually rigorous systematic data analysis, I asked the following six guiding questions. I justify each guiding question with the literature. Each of the guiding questions is represented by a column in Tables 5.1-5.4. Each table presents the identity work, identity resources generated, and shifts of identity for each of the case study girls.

Guiding Question 1: What are the practices and resources that these girls are leveraging? Guided by social practice theory (Holland et al., 1998), I aim to understand how STEM learners generate meaning of self in relation to the local patterns of meaning surrounding them (Calabrese Barton et al., 2013). Students who engage in learning activities creatively use resources to fashion new possibilities for making sense of and participating in a social world (Carlone et al., 2011; Eisenhart, 2000). Students acquire cultural resources through participation and create shifts toward either reproduction of culture or production of new culture (Carlone &

Johnson, 2012). By leveraging other resources, girls open many opportunities and pathways to acknowledge the multiple experiences of girls of color (Calabrese Barton et al., 2008; Carlone et al., 2014). Therefore, by paying attention to leveraged practices and resources, I am attending to the new meaning of science and self that these girls are engaging in. This helped me answer the first research question by explicating what resources from other settings are leveraged.

Guiding Question 2: What are the ways in which the girls are recognized and positioned when doing science? Guided by social practice theory (Holland et al., 1998), I paid attention to identity work as an ongoing process of becoming where there is a negotiation of meaning, positions, and contexts (Calabrese Barton et al., 2013; Holland et al., 1998; Tan et al., 2013). The practices and discourses during identity work that shape an identity must be enacted and recognized (Gee, 2000). This recognition and positioning are pivotal points where social interactions shape identity (Holland & Leander, 2004). The process of positioning is not the only interaction that shapes identity. In fact, being positioned is itself an identity shaping interaction (Holland & Leander, 2004). Therefore, close attention must be paid to recognition work to understand the pivotal points and shifts in meanings and identities.

Recognition work is recognizing oneself and being recognized by others as a science person (Carlone & Johnson, 2007). As a social interaction, recognition work becomes a pivotal point that shapes identities (Holland & Leander, 2004). Through recognition, one creates meaning with others who are participating in practice (Zimmerman, 2012). This can mean recognizing and positioning girls as capable or experts of doing science. Therefore, by paying attention to recognition work and positioning in the data analysis, I am seeing 1) who is either recognized or being recognized, 2) how the recognition work shapes identities, and 3) what new

Table 4.1. Activity System for Each Observation

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
10.19.17	Students determine the ingredients for a cookie and their favorite recipe	Digital technology, and recipes	Don't eat the cookie, and use iPad for research, use of Spanish to talk and joke with students	Home based communities, talk about food they eat at home	Students all had a food to talk about and eat	Some sort of recipe guide	Learning about food chemistry
10.26.17	Students make microwave cinnamon roles	Kitchen chemistry worksheet and cooking tools	Focus and pay attention, following recipe, discuss wrap up	Home based community practices about food	Students first listened, then they were reproducing what Tessa did	Cinnamon rolls and worksheets	Understand scientific concepts of mass
11.03.17	Students do their first Science and Me and present their work	Students had worksheets with the prompts	Students had to answer the questions on the prompt and were able to freely talk with their peers, Spanish was used to tell kids to clean up	Many students talked about their ethnic background and their home situations	Students had ownership to be able to craft their own presentations	Science and Me Artifacts	Learning about science in their everyday lives
11.09.17	Students create PowerPoints on Radio Wave and Chemical Energy to develop their background knowledge	White board for discussion, iPad for information, PowerPoint for communications	School based norms of lectures. Students were allowed to walk around and visit other groups. Students use Spanish if needed to talk about ideas	Students talk about their school communities and how they never do activities like this	Teacher first initiates and then students respond.	PowerPoint the students made on energy and the notes they took on the iPad.	Science knowledge about energy. Practices at home include technology and art based googled drawings

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
11.16.17	PowerPoint presentations on their energy. Then students create a poster discussing the real-life implications of their energy source.	PowerPoints were used to present, and posters were used. iPad were used to look up information and to keep track of their notes.	There were formal presentations that students needed to have and the poster was heavily based on application of scientific knowledge to a real world phenomenon, Spanish use for *dichos*, Spanish to connect with students	Students could describe their examples in communities that are real like in the home-based life or imagined creative worlds	Students had to present, sit while teachers explained activity, and then students worked on projects where they could take ownership of what they wanted to do in terms of application and content.	Students had PowerPoint presentation s from the previous lesson and posters made for the second lesson	Students worked on presentation skills, application of science to everyday lives, and story-telling skills.
11.30.17	Students present their energy poster and students also FaceTime Carlos at the Mercado (food pantry)	Posters were used as tools as well as iPhone FaceTime	Students had to respect the speakers. During the FaceTime event, students were asked to be quiet to hear Carlos, but they were able to ask any questions they wanted about the Mercado, Spanish for ideas	Communities include home based resources like family time and community based like social services	Students worked in teams on posters where they presented information. Students worked in pairs when taking down information about Mercado and were able to answer individual questions	Students has posters and worksheets that kept them accountable for their learning and engagement	Students learn more about their energy, interests in home and community life, healthy and unhealthy foods, and their own personal resources at school

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
12.07.17	Students are working on their script and their short film.	Students are using iPads as a tool to edit their videos	Students have to combine scientific ideas and think about the communities they want to share it with. Students has access to markers and paper to create props and are allowed to tell any story as long as it focuses on communicating information to a larger audience. Students are able to also communicate in Spanish, if needed for ideas, science for connecting	Students talk about the Mercado, the grocery stores they go to, the school community, and their local community.	Students were able to decide what they wanted to share with their communities. There were no formal roles but any included editing, filming, directing, and prop making.	Students made their videos and their props for their videos	Student learn about telling a story, writing a script, thinking about the science as a public resource, and creating a multimedia project
01.18.18	Students review science topics they learned about ecosystems and completed a worksheet on modes of communication.	Students use iPad and laptops to talk about science and communication to look up information	This is a classroom center rules where students are asked to review a concept and gain some sort of understanding,	Many are drawing from the home when talking about ways they communicate such as phones and mobile apps on phones.	Students had typical schoolwork labor divided up where they worked on worksheets in pairs	Worksheets that focus on their ideas about ecosystems and communicat ion	Students learned more about communication and the technology they typically used.

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
01.25.18	Students are reviewing they key terms of an ecosystem. They all watched the YouTube video of an ecosystem and took notes.	Students had the computer to watch the YouTube video of the ecosystems. Students also had a worksheet to answer the key terms.	School like rules such as students watching the video and reproduce what they see and hear in the school setting., Spanish ideas,	Students are drawing from the school community and the rules that come with when watching the video on YouTube.	Students were working in groups to fill out the worksheets	Student worksheets with the key terms	Learning about ecosystems, decomposers, consumers, and producers
02.01.18	Students start to identify the ecosystem they want to focus on and the problems. They then begin to conduct research on background knowledge of their ecosystem.	The iPads to search up information and the guiding questions to keep them accountable for the goal of the activity.	Students had to stay on task of the activity. Certain students were allowed to conduct research on the iPads. Students can freely ask the questions they want and also hold side conversations including technology use and bond with their UCI educators, Spanish ideas	Students working with the local ecosystems they want to describe. Students drew on the ideas from the local afterschool community and the bonds they have with teachers and peers	Teachers acted as behavioral guides and students were given expertise of their ecosystem.	Students had their worksheets about the guiding questions to keep them accountable to their work.	Students learn more background knowledge of their ecosystem and the rules they will take on for the media project.

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
02.15.18	Students are presenting skeleton outlines of the problem in their ecosystem and present it to the classroom.	Skeleton structure worksheet and iPads to look up information	Students divide up the labor amongst themselves	School community because of the skeleton structure and the communities of their ecosystems.	Students were divided and worked on the different questions of their skeleton outline	Poster and skeleton outline	Learning more about the ecosystem and participant structures
02.22.18	Students are showing their science artifacts from home	Students brought tools from their homes as artifacts	Students were able to use Spanish to express their science artifact	Home based communities where the students bring something from home including online and family	Students were authorities of their objects and everyone listened and learned	Artifacts that represent science to them	Interests and connections in science and building a community
03.01.18	Students are working on their planning and budgeting for their ecosystems. This includes searching background information	iPads were used to be able to search background information	Everyone contributes and Lulu keeps pressing everyone to complete task. Spanish was used to get students to work together and discipline students, Spanish connect	Students were drawing on home knowledges, arts and crafts from home, and talking about music.	Students were asked to determine roles and what was appropriate for the project	Goal setting and budgeting worksheet	Students learned to plan a project as well as the background for their individual projects

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
03.08.18	The groups are building their diorama to be used as a prop for filming	Materials include arts and craft materials	Students are able to move back and forth, listen to music, and gather supplies whenever they wished. Spanish is also frequently used to talk about safety, stay on task,	After-school program is where the students are working in and they are bringing their home material resources.	Students have roles they have volunteered and assigned to do; some students don't have any roles	The setting and backgrou nd for their ecosyste m project	Learning about what belongs or does not belong in their ecosystems.
03.15.18	Students are working on the diorama and making practice video recordings of their script	Students are using the supplies they have such as animal toys to finish their dioramas. Students are also using iPads and cell phone to access video editing technology.	Spanish was used to motivate people to complete the work, Spanish for discipline. Students had to ensure that their projects were still scientifically accurate	Talking about their ecosystem community, online community like Snapchat and video editing software, and home community when bringing in school supplies.	Students were working on editing, filming, and making last minute additions to the diorama	Diorama about the forest ecosyste m and the video that was created using Snapchat	Students learned more about how to edit videos and the science behind the animals they selected for their diorama.

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
04.12.18	Students are taking the last opportunities to edit their videos for their ecosystem project.	iPads are used as recording devices. Students also have their dioramas they are using.	Depending on the groups, students either could use personal technology for music or they were asked not to use any personal technology. Spanish was used in side conversations	Communities they were working with was the groups they were working with	Students mostly had a role, even though some didn't and they stood back because they didn't have an expertise. Teachers were only used as helping the students stay on task.	Each group had a diorama and had a video	Learning more about their ecosystem when trying to memorize their lines and learning more about video editing.
04.26.18	Students are watching the class's ecosystem video and filling out a worksheet to keep them on task. Students then work on their Science and Me.	Video projectors to project their videos, worksheets to keep the students accountable, and iPads and art supplies for Science and Me	Students has to be respectful while others were presenting. Students could inquire questions with other groups projects and they also had to be prepared to answer their questions from the classroom, Spanish was used for side conversations for connecting	Afterschool community and the communities that are represented in their ecosystems	Students had roles as experts in their ecosystem video and they were also held accountable from learning about other ecosystems.	Worksheets on other groups' videos and their own videos	Learn more about ecosystems and establish expertise in their own ecosystem

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
05.03.18	Students were finishing Science and Me project and were brainstorming their solutions for the Engineering Project	Students were using posters and using drawing worksheets	Students had to work cooperatively, and the teacher was ensuring that was happening. Students had no limitations on the type of invention that wanted to work on, Spanish use for accountability	Home based practices such as listening to music. After-school program that was focused on engagement of activities.	Students were arguing and belittling each other, adults had to make sure to mediate across the groups.	Poster and worksheets that had the guiding questions for the project	Learning more about students through Science and Me and start thinking about engineering design.
05.10.18	Students are working on the blueprints for their prototype.	Students are using worksheets to act as blue prints. Students also have power tools to start building their prototype. Students also had access to laptops and iPad to start looking up information	Alondra Spanish to connect, Lulu Spanish to connect, Spanish for ideas Students have unlimited creativity when thinking about their prototypes.	Students talk about family and home life experiences like listening to K-pop and making drones.	Students work on projects with unclear division of labor even when some of them were assigned roles	Students are building prototypes using various tools, drafting blue prints on paper, and using construction tools	Learning more about the engineering design cycle, learning how to build items, and going from drawing to prototype to test

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
05.17.18	Students continue to work on their prototype and receive feedback from another UCI educator.	Students are using tools such as the computer. Worksheets and posters are used to draw out their ideas.	Students were held accountable for their own projects and contribution. Educators also used Spanish when communicating with the kids (*dichos*)	Community of group work	Students each have a role and when they receive feedback from other people, they take their feedback into account	Prototypes from the Engineering a solution	Working on something different to find an intellectual contribution
05.24.18	Students are working on their projects and are building the first prototype after experimenting with materials	Students are using soldering irons, chargers, and batteries to create their project	Students are using tools they normally wouldn't be able to use. Computers are also being used. Spanish was used to scold students for safety concerns and build bonds	Students are drawing on home based practices such as drill use	Students have to find ways to take ownership of their work	Individual projects and prototypes	Learning about building and testing prototypes and use of new tools
05.31.18	Students are working on their prototype for engineering design	Students have computers to use to be able to write about their projects.	Students were able to use Spanish when being scolded by lulu and accountability. There was accountability for scientific knowledges and practices.	K-pop community and afterschool community on the engineering design cycle.	Students were talking to about how to contribute to the larger task at hand	Individual group projects such as prototypes and white board drawings	Learning more about science knowledge and engineering design cycle.

Date	Activity Description	Tools	Rules/Norms	Community	Division of Labor	Artifacts	Learning Outcomes
06.07.18	Students are working on a poster that represents the engineering design cycle. UCI teachers also individually recognized each group for their participation after the student presentation	Students have access to the model of the engineering design cycle and the posters to present	Students had to use their previous work to see where each step fills into the engineering design cycle. UCI teachers also used Spanish to speak to the parents in the awards ceremony.	Students are in the community of afterschool group work but also remember that their parents are coming to watch them present, home and family	Student labor is divided evenly amongst each other where they need to work together to argue about what they did in the engineering design cycle	Engineering design cycle poster and prototype	Students learned about presenting to the parents and connecting all their process to the engineering design cycle

meanings of self are shifted through recognition work. This helped me answer the research question by helping me understand what leveraged resources from other settings are recognized.

Guiding Question 3: What are some ways girls are not recognized which become missed learning opportunities and untapped resources? If being recognized mediates identity work and is a pivotal point in shaping identity (Calabrese Barton et al., 2013), data analysis should also be guided by understand what is *not* being recognized. When focusing on what is not being recognized, students are still positioned as being a certain type of person, (i.e. not a science person). This leads to differences in narrated and embodied identities in practice where how girls describe themselves is vastly different from how they are recognized (Tan et al., 2013). This helped me answer the research question by helping me understand what leveraged resources from other settings were *not* recognized and become a missed opportunity.

Guiding Question 4: Who is doing the recognition work and positioning? This particular guiding question is framed around *who* is doing the recognition and positioning. In doing do, it highlights the different ways of successful recognition, redefining recognition, and understanding how recognition is disrupted (Carlone & Johnson, 2007). Furthermore, the recognition work of the girls' identities in practice is tied to their available resources, the power dynamics of authority in the activity system, and what is possible in their future selves (Tan et al., 2013). Therefore, by paying close attention to *who* is doing the recognition work, I intend to uncover 1) successful recognition, 2) disruptive recognition, 3) available resources, and 4) the power dynamics of the setting. This helped me answer the research question by helping me understand who is doing the recognition work.

Guiding Question 5: What are the identity artifacts that emerge from identity work? Guided by social practice theory (Holland et al., 1998), I pay attention to the identity work and the mediating identity artifacts that are both products and processes of identity work. In using social practice theory of identity, these identity artifacts reflect the relationships and specific practices and positions (Leander, 2002). Identity artifacts become reflections of practice and the meanings they take on (Holland et al., 1998; Wenger, 1998). Therefore, close attention must be paid to identity artifacts to understand the process and products of identity work.

Guiding Question 6: How is language used as a resource when doing science? Given a review of literature, an underexplored area is how language by non-dominant Latina students is leveraged and recognized when developing a science identity. As literacy research has developed from a socio-cultural perspective, educators and researchers have expanded on ways in which Spanish can be used as a literacy practice to engage students in their learning. Language is not only used as a way of communicating but understanding, making meaning of the world, and identity development (Gee, 2000; Rosebery et al., 2001). Written and verbal Spanish have also been used to legitimize the language and allow students to afford in scientific vocabulary and ideas (Garza & Arreguín-Anderson, 2018). Therefore, by paying attention to language in the data analysis, I am seeing Spanish as a tool for meaning making in science identity development.

Fourth, I organized the Interesting Events both chronologically and by setting (during school, after-school STEM clubs, family related events, and others) using a spreadsheet. I then looked at each interesting event to identify which resources were leveraged from other settings and how the resources were recognized by others, such as peers and teachers. I then coded the Interesting Events. Codes were generated from the data where I kept in mind the non-deficit perspective of my research and my expansive view of resources. Codes described resources and practices of students across settings by comparing and contrasting which resources appear in multiple settings to indicate identity resources. Generated identity resources were linked to a shift in sense of self. Open low-level inductive coding was grounded in the rich and thick data. Doing so generated profiles of the case study girls' STEM engagement and described the cultural resources and practices leveraged. Codes were generated from the data and guided by the conceptual framework of identity resources. Open high-level inductive codes of generated identity resources were generated. I also paid attention to any identity artifacts.

Identity artifacts are produced during identity work to show how identities are stabilized and destabilized over time (Calabrese Barton et al., 2013). These artifacts can include weird drawings (Calabrese Barton et al., 2013) and computer science games (Liu & Kang, Under Review). Identity artifacts mediate recognition work by showing the shifts meanings of self (Holland & Leander, 2004; Leander, 2004). Identity artifacts are able to be given meaning and transformed to change the activity and activity systems (Leander, 2002). Therefore, by paying attention to identity artifacts in the data analysis, I intend to understand 1) how identities are stabilized & destabilized, 2) the recognition work that occurs, and 3) the tools of the activity system. This helped me answer the research question of what semiotic and physical artifacts emerged from the identity work (Nasir & Hand, 2006).

Fifth, from the Interesting Events, I generated a table of Critical Events to understand different patterns of STEM identity development. I define Critical Events (CE) as an event where a) there were any shifts and patterns in participation of STEM engagement, b) identity artifacts, if any, emerged, c) resources from other settings were leveraged, d) leveraged resources were recognized or not recognized (a missed opportunity), and e) identity resources were generated. From the 324 Interesting Events, I coded 66 Critical Events for the four case study girls. From these CE, I generated a table of Critical Events for each case study girl.

To show how Critical Events were selected, I describe how two Interesting Events became Critical Events. Critical Event #3 for Maz was selected because it demonstrated a) a pattern of sustained participation in the activity, b) an emergence of the poster as an artifact, c) leveraged resources of science facts and performing, d) recognition from self, and e) generation of the identity resources of science and performing. Critical Event #8 for Maz was also selected because of a) a pattern of sustained participation in the activity, b) lack of identity artifact generated, c) resources of home and science camping leveraged, d) these leveraged resources *not* being recognized, and e) no identity resources generated because of the missed opportunity.

To further show how Critical Events were selected, I describe how an Interesting Event determined not to be a Critical Event. Take, for example, an Interesting Event on October 19, 2017. During an introduction game, students shared to the group what TV shows they were interested in and various other fun facts. Maz indicated that her favorite TV show is Star Trek. A boy responded with, “FANCYY” complimenting Maz. This was considered an Interesting Event because Maz was recognized for her home-based practice of watching Star Trek. However, it was *not* considered a Critical Event because there was no change in STEM engagement or participation and no identity artifact emerged.

Sixth, from the Critical Events, I generated an Identity Heat Map (Figure 4.1) to understand the different ways in which the girls participated in the STEM activity. A heat map is a visual tool and “graphical representation…, which compacts large amounts of information into a small space to bring out coherent patterns in the data.” (Weinstein, 2008). As part of the heat map, I categorized each of the Critical Events into one of four categories: (a) manifesting sense of self in science, (b) destabilization: toward sense of self in science, (c) destabilization: toward sense of self away from science, and (d) sense of self not in science. When examining the

Critical Events, I looked to see if there was a change in participation in the activity. If engagement and identity resources were generated during identity work, the Critical Event was coded as “sense of self in science.” If there was no engagement at all, the event was coded as “sense of self not in science.”

With the remaining Critical Events, I compared and contrasted each event to the one preceding it and the one following it. If I saw a change in and participation and engagement, I coded it as destabilization. Then, from destabilization, I coded it to see if it was a destabilization toward STEM or away from STEM. Next, I color-coded each of these codes so that I could visually see shifts and changes across Critical Events in order to identify patterns. Methodologically, this means that I am able to use my data to visually describe changes in participation and shifts in identity occurring during identity work.

For the interviews, I created a portrait of the Mexican-American case study girls based on their interviews. I focused on comparing and contrasting their identity work and experiences with STEM, how they position themselves in STEM, how they are recognized for their achievements, current and future sense of self, and reflection on the after-school program. For the teacher interviews, I created a pre- and post- portrait of how they positioned the Mexican-American girls. For the other actors, I then focused on what role they played, if any, in supporting the STEM identity work of Mexican-American girls. I then connected this back to my spreadsheet of video-captured interactions to see if that actor played a role in supporting the generation of identity resources.

For the surveys**,** I compared and contrasted averages for the Mexican-American girls on various items to see if there were any shifts in their sense of self in STEM. I take this difference in pre- and post-scores as an opportunity to contextualize the shifts of their senses of self. This

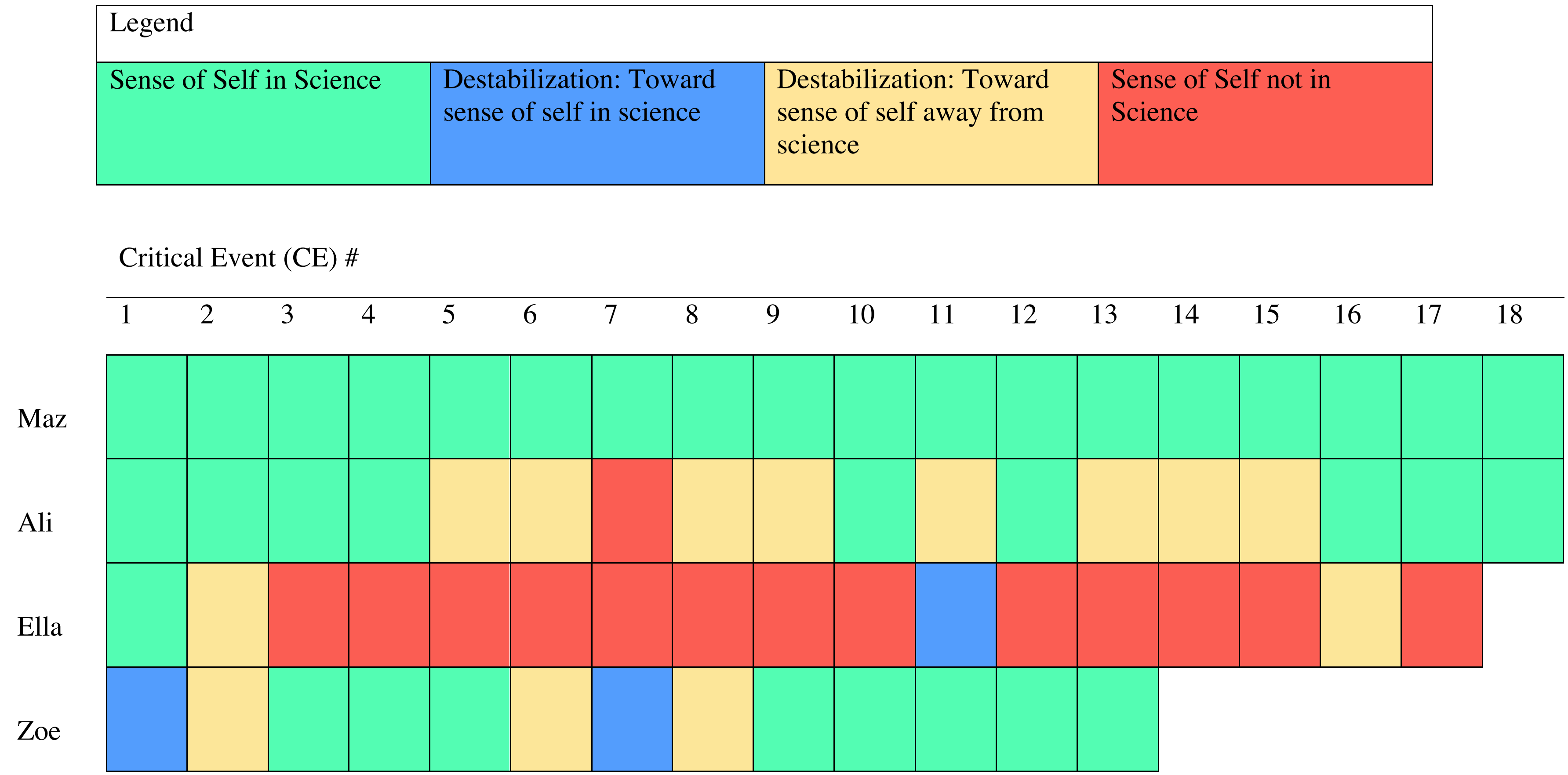


Figure 4.1 Identity Heat Map

supplemented the aforementioned interview data and enriched the portraits of the Mexican-American girls in the case study.

Artifacts from the identity work were matched to corresponding Critical Events on the spreadsheet. I then examined each identity artifact for possible generated identity resources, where the resource originated from, and if any other actors were involved in generating the resources from setting to setting. The artifacts from the school were used to describe the school setting, in particular the classroom setting. This description helped contextualize the power dynamics, resources, rules and norms of the school and the classroom. Any additional information was added to the portraits of the Mexican-American girls.

Trustworthiness

To ensure trustworthy data, I followed the four attributes of credibility, transferability, dependability, and conformability (Lincoln & Guba, 1985) in addition to practicing triangulation (Carspecken, 1996). To ensure credibility (Lincoln & Guba, 1985), I sustained prolonged engagement (having been at the site since February 2016 and having spent one academic year with the case study girls), practiced persistent observation (through my weekly afterschool STEM program and with undergraduate research assistants spending time at the school site), conducted member checks (with the families, Mexican-American case study girls, teachers, and research assistants), and used consistent data collection protocols and procedures. To ensure transferability (Lincoln & Guba, 1985), I collected multiple pieces of rich and thick data. To ensure dependability (Lincoln & Guba, 1985), I coded and recoded data, discussing the findings and data with my committee, participants, research colleagues, and undergraduate research assistants. To ensure confirmability (Lincoln & Guba, 1985), I generated an electronic audit trail of data, analysis, and findings. I also triangulated my data using multiple data sources and devices, member checks, and debrief to check for biases (Carspecken, 1996).

CHAPTER 5: FINDINGS

Four Cases of STEM Identity Development:

Where the Third World grates against the first and bleeds,

We have learned to love ourselves,

I also realize that I was a long way, still, from finding my voice,

Still I'll rise.

Introduction

The overall patterns of the data are described in the Identity Heat Maps (see Figure 4.1). As part of this analysis, each Critical Event was examined for shifts in identity. Shifts in identity were coded as either high sense of self (green), destabilized sense of self toward science (blue), destabilized sense of self away from science (yellow) or low sense of self (red). For each case, Critical Events were studied across time for patterns and trends. I noticed four distinct patterns of shifts in identity across time.

Maz's steady identity trajectories, the Case of Hybrid Practices, are shaped because Maz *leverages* her bilingual resources and family-based resources such as volunteering at the school pantry and is *recognized* for bringing materials from home to support her science learning. Ali's shifts in identity trajectories, the Case When the Highs are Greater than the Lows, are informed by how Ali leveraged practices and tools from home such as food and technology, bonded and engaged in these home practices in a learning setting and was able to have after-school program be a counter-space to support her interests (e.g., K-pop). Ella's shifts in identity trajectories, the Case of Finding her Voice, are shaped because Ella created counter-spaces in the after-school program by challenging social exclusions and leveraging bilingual resources to bond and build relationships with educators. Zoe's shifts in identity trajectories, the Case of the Risen, are shaped because Zoe created a counter-space and recognized her own science accomplishments and was supported in her endeavors through Spanish.

Road Map

Overall, four patterns of identity work emerged from the four case study girls' STEM identity trajectories (see the Identity Heat Map in Figure 4.1) This chapter presents four cases in detail. The chapter also includes the findings from the cross-case analysis. For each case, I first describe each case study girl and introduce their family experiences, after-school experiences, school experiences, positioning of self in science, and positioning by teachers. Second, I show the pattern of STEM identity development that each case study girl represents. Finally, for each girl I unpack how and why the girls show various patterns in leveraging and recognizing identity resources by showing a Critical Event. Together, the analysis revealed two patterns: (a) having a productive role becomes opportunities to generate identity resources and (b) recognition work is relative in a setting where a group of students participate in activities.

Case 1: Maz - The Case of the Hybrid Practices

"The U.S-Mexican border es una herida abierta where the Third World

grates against the first and bleeds. And before a scab forms it hemorrhages again,

the lifeblood of two worlds merging to form a third country — a border culture."

- Gloria E. Anzaldúa, Borderlands/La Frontera: The New Mestiza

Maz was a 5^{th} grade girl who identifies herself as ethnically Latina. Maz's family includes her father, mother, and two younger twin sisters. Maz's dad is a medical assistant who sometimes brings "random books from work down at 17^{th} street." Maz is unsure what her mother does for work. During this time, Maz was attending catechism, a multiyear learning experience through the church to understand the guiding principles of Catholicism. In addition, she and her father volunteer at the *Mecado El Sol,* a local food pantry on site. Furthermore, Maz loves to exercise and has participated in running events with her family. These events also complement the times when the family eats ice cream at *La Michocana Ice Cream*, a Mexican ice cream parlor. She also likes to play games with her sisters, including tag and playing on the swings.

After-School Experiences. Maz is proud her ethnic culture and participates in traditional Mexican folk dance (*folklorico*). She also performs *folklorico* competitively and for wider community events such as at the Heartbeat of Mexico at Chapman University.

School Experiences. As part of her school experiences, Maz's teachers say she is a hard worker, who is involved and participates but can also be stressed out and nervous. Every Monday, her father comes into the classroom and helps clean the desks. The teachers always chat with him and hear that Maz is striving toward student of the month and hopes she wins school awards.

Positioning Self. Over multiple occasions, Maz has mentioned she wants to be either a food scientist or food chemist. On her survey in the beginning of the year (12/6/17), Maz indicated high interest in science, high science achievements, high participation in science activities at home (reading books about science/science fiction, taking care of animal/plants, talking to family about science, looking up science information), and fairly high interest in pursuing a science career. On the year end survey (6/1/18), all of Maz's responses remained consistent. Maz says, "if I were a scientist, I would be a food chemist. There are the things I would do: First, I would like to invent ice cream that never melts. I would like to play with the ingredients that are used to make ice cream. Also, I would like to make ice cream chewy and very cold. This is why I want to be a food chemist."

Positioned by Teachers. Maz's teachers are rarely worried about her academic performance. If Maz is ever out, her teachers state they never need to initiate follow ups with her. Being a responsible person, Maz always figures out what she needs to make up in terms of her work. In fact, her teachers even state that they are concerned about how stressed out Maz is in regard to her academic achievements. Her teachers value her work ethic and have learned to accept Maz's perfectionism over time.

Summary of Maz - The Case of the Hybrid Practices

The Case of Maz across her Identity Heat Maps (see Figure 4.1) demonstrates a high sense of self in science across all Critical Events. Maz was not recognized only by her teachers as a science person, she also recognized *herself* as someone who can do science. From the Critical Events, three consistent patterns arose: use of bilingual resources, leveraging of family time, and practices and tools traveling from home were all leveraged and recognized in generating identity resources.

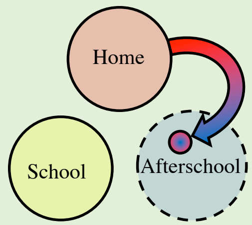
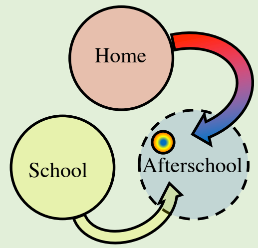
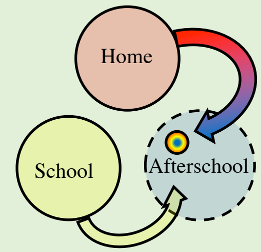
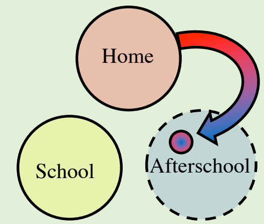
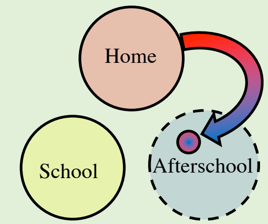
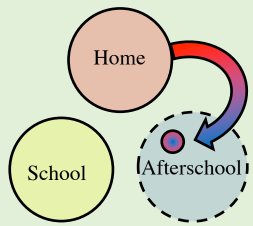
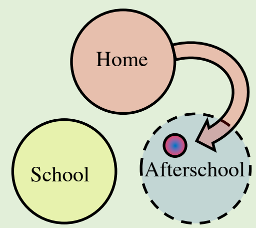
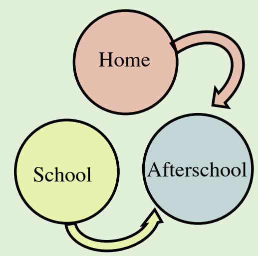
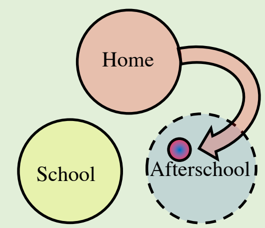
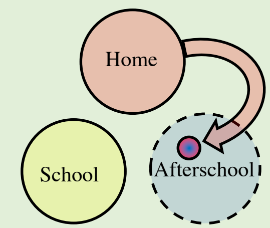
Maz, as the Case of Hybrid Practices, was able to counter dominant narratives of what successful Latina girls in STEM look like. Rather than focusing on what Maz does not have, findings show that Maz has many incredibly rich cultural resources and practices. Not only were these resources and practices leveraged, they were also recognized by both Maz and her peers. Furthermore, Maz challenged traditional norms and expectations of being successful in STEM by leveraging her various resources including Spanish and home resources, countering dominant narratives of what it means for a Latina to learn STEM.

Overall, Maz's pattern of participation and engagement in the after-school program starts off high, remains high, and ends high. All of the total fourteen events (see Table 5.1) that were analyzed showed strong promise of Maz's high sense of self in science. Maz was connecting scientific practices to home practices, demonstrated and was recognized for her expertise in science, and in some moments even showed higher interest and participation in science. To better understand how Maz's generated identity resources, I combined the conceptual framework of identity resources (Figure 3.1), the Identity Heat Map (Figure 4.1), and the Critical Events table (Table 5.1). Creating Maz's Generated Identity Resources (Figure 5.1) helps us understand how resources were leveraged, whether they were recognized, how identity resources were generated, and how generating identity resources is tied to Maz's STEM engagement.

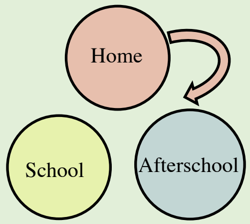
Maz is the Case of Hybrid Practices because she is able to leverage her home resources into the after-school space to deeply engage in STEM. Furthermore, drawing on the ideas of Anzaldúa's Borderlands, Maz is neither "*español ni inglés* [Spanish or English], but both" (Anzaldúa, 1987, p. 55). She draws from both sets of worlds to engage in these activities. Furthermore, Maz leverages many of her bilingual language resources to both engage in scientific disciplinary practices and in STEM activities.

Bilingual Resources. As a Spanish speaker, Maz uses Spanish to articulate her ideas and thinking in science. Some are successful attempts in using Spanish (see Critical Event #2) where she talks about science in both English and Spanish. There are even attempts in which Maz has trouble articulating ideas in Spanish (Critical Event #5 and #6). Despite the fact that she is stumbling through her Spanish, Maz is making a concerted attempt to articulate her ideas which comes easiest to her. Through her use of Spanish, Maz is not only articulate her ideas in both English and Spanish, but she also connects to other teachers like Alondra and Lulu.

Vignette. In Critical Event #5, after discussing chemical energy in foods, the educators came up with a short culminating project for the students. The project was centered around the idea that students learned large amounts of content knowledge about energy and should share.

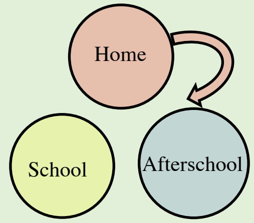
Critical Event #1  Event: Recipe Resource: Home food resources Recognition: David Identity Resource: home and food resources	Critical Event #2  Event: Electrical energy Resource: School ELMO and Spanish Recognition: Self Identity Resource: ELMO projector and Spanish	Critical Event #3  Event: Speed of light Resource: Science facts and performing Recognition: Self Identity Resource: Science facts and performing	Critical Event #4  Event: Helping at the Mercado Resource: Volunteering with dad Recognition: Tessa Identity Resource: Volunteering at Mercado	Critical Event #5  Event: Transfer in Energy Resource: Spanish Recognition: Tessa and Lulu Identity Resource: Spanish language
Crtitical Event #6  Event: Flip phones Resource: Home resources Recognition: Tessa Identity Resource: Home phones	Critical Event #7  Event: Long distances Resource: Spanish Recognition: Lulu Identity Resource: Spanish	Critical Event #8  Event: Ecosystem Resource: Home and camping and science camp Recognition: None Identity Resource: N/A	Critical Event #9  Event: Global Warming Resource: Beach ecosystem Recognition: Peers Identity Resource: Beach ecosystem	Critical Event #10  Event: Show and Tell Resource: Harry Potter memory experiment Recognition: David Identity Resource: Harry Potter memory experiment from home

Critical Event #11



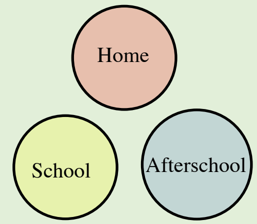
Event: SHINNY
Resource: SHINNY song from Moana
Recognition: N/A
Identity Resource: N/A

Critical Event #12



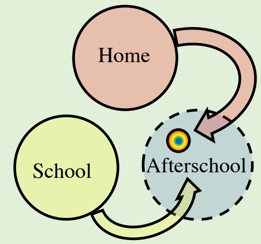
Event: Bringing Own Supplies
Resource: Home supplies
Recognition: None
Identity Resource: Home supplies

Critical Event #13



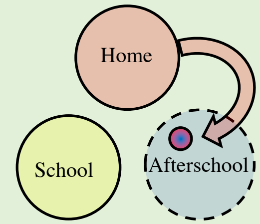
Event: Film Video
Resource: N/A
Recognition: Sophia and Self
Identity Resource: N/A

Critical Event #14



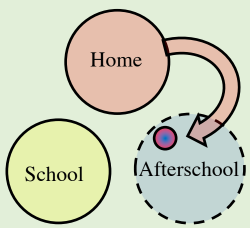
Event: Getting Recognized
Resource: Technology
Recognition: Ms. Paloma and Alondra
Identity Resource: Home and school

Critical Event #15



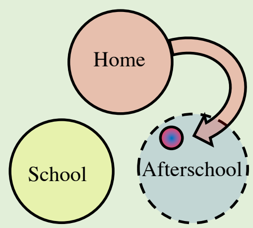
Event: Cleaning the beach
Resource: Drones
Recognition: Maz
Identity Resource: Drones and Family Science Night

Critical Event #16



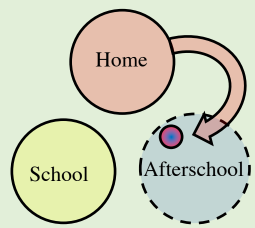
Event: Building and Drafting
Resource: Power tools
Recognition: Self
Identity Resource: Power tools

Critical Event #17



Event: Building batteries
Resource: Power tools
Recognition: Alondra
Identity Resource: Power tools and batteries

Critical Event #18



Event: Award Ceremony
Resource: Home resources and materials
Recognition: Alondra
Identity Resource: Home resources

Figure 5.1. Maz's Generated Identity Resources
Note. More information about the Critical Event is found on Table 5.1.
Identity Heat Map: Green = sense of self in science, destabilization: Blue = toward sense of self in science, Yellow = destabilization: toward sense of self away from science, Red = sense of self not in science.

Table 5.1. Events for Maz (Starred Events are Critical Events [CE] Written in the Findings)

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #1 10.19	When looking up home recipes, Zoe used YouTube to search up how to find mayonnaise and Maz stresses that it's easy to make tamales	Home-based resources such as cooking and talking about what they do at home and how it connects to science	Maz used Spanish when talking about the cookie and its ingredients when asking Zoe to hand them over.	When Maz was saying that tamales are easy to make, David asks what the secret is positioning her as an expert. The whole group agreed that tamales are actually quite difficult to make.	None	David did the recognition work	YouTube videos of the recipes they were looking up and the recipe cards of the cookie	Interest in science starting to develop and connection to home-based cooking practices	High sense of self; connecting science to home practice

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #2 *11.9	When discussing electrical energy, Maz talks about how the energy flows from the cables to the ELMO of the classroom using Spanish. She also talks about cables and the energy used in Spanish.	Bilingual and school resources. She switches back and forth between Spanish to talk about ideas of energy. Furthermore, she related the idea of energy to things she sees in the classroom such as the ELMO. She also talks about how she uses energy in cables and computers	Maz uses Spanish to talk about ideas of energy that she sees in computers and cables at home and at school	Maz positions herself as someone who is an expert.	None	Maz positions self as an expert saying things come easily to her, particularly when talking about energy	PowerPoint related artifacts and notes they are taking	Expertise in science and bilingual skills	High sense of self; high expertise

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #3 11.16	During the poster presentations, Maz describes how the speed of light is instant to try and help Estrella reinterpret what she is saying.	Science based knowledge resources and performance-based resources, maybe from *folklorico* and dancing on stage	None	Maz positions herself as an expert in science by knowing a lot about scientific information	None	Self	Poster presentation from the radio waves poster	Expertise in science, in particular for the classroom community	High sense of self; high expertise

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #4 *11.30	Maz discusses how she and her father help out at the Mercado. She is the only one who has any inside information about the Mercado and Alondra asks everyone to listen to her as she explains.	Home based resources and community-based resources when talking about volunteering with her dad at the Mercado	None	Recognized by Tessa as someone who has something to contribute to the discussion because nobody else has had any experiences with it.	None	Tessa is recognizing Maz that she has something to contribute to	Poster from the presentation and any type of papers that are made because of the conversations they have FaceTiming Carlos	Develops interest in home and community life and unhealthy and healthy foods	High sense of self; development of scientific knowledge

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #5 *12.07	Maz tries to use both Spanish and English when trying to write a script. It has something to do with transfer of energy but Maz kept saying she forgot in Spanish	Home based Spanish resources to try and communicate the science ideas	Used in conversations when trying to explain scientific phenomenon.	Lulu is trying to help her remember. Tessa says it's okay but Tessa and Lulu try and help her remember what she is trying to articulate	None	Tessa and Lulu are recognizing that she is trying.	Script writing and worksheets	Learning more about energy and how to communicate that to the community	High sense of self; development of scientific knowledge
CE #6 01.18	Maz talks about the flip phones She talks about communicating using phones and Tessa engages in a conversation with her.	Home resources such as chatting on the phone.	None	Tessa recognizes Maz's intellectual contribution	None	Tessa	Worksheets	Learning more about communication and the affordances and constraints.	High sense of self; development of scientific knowledge
Date	Description	Resources	How is	How Are	How are	Who is	Identity	Outcome	Sense of Self and

		Leveraged	Language used as a Resource	Girls Recognized and Positioned	Girls NOT Recognized (Missed opportunities)	doing recognition work	Artifacts		Shifts in Identity
CE #7 *01.25	When talking about communication, Maz talks in Spanish about long distances.	Spanish linguistic resources and home based resources such as calling people on long distance	Used as a bilingual resource to switch back and forth between English and Spanish	Maz is recognized by Lulu that she can answer in English if she can't in Spanish	None	Lulu recognizes Maz for her attempt at explaining in Spanish	Worksheets	Learning more about communication	High sense of self; connecting science to home practice
CE #8 02.01	When asked what ecosystem they are a part of, Maz says she is part of the forest ecosystem and talks about bad parts such as getting lost and poison ivy	Home based family experiences such as camping. School based experiences like science camp.	None	None	None	None	None	Starts making the connections between outdoor camping experiences to some of the understanding of ecosystems.	High sense of self; development of scientific knowledge

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #9 02.15	Sophia tries to destabilize Maz's expertise in science. Maz then corrects Pedro about his ideas of global warming.	Leverages resources about the beach ecosystem that she learned about.	None	Initially, Maz was positioned as a non expert. Then, Maz positioned herself as an expert when correcting Pedro.	None	Maz's peers were recognizing her as a science person and non-science person	Poster and skeleton workshe et.	Learning more about coral bleaching when destabiliz ed and tries to publicly stabilize her science ideas	High sense of self; development of scientific knowledge
CE #10 02.22	Maz does a memory experiment with Harry Potter references	Home based resources such as playing games with her siblings and Harry Potter related interests	None	David positions Maz as someone who does science like experiments	None	David	Harry Potter books she was reading and wands.	Engaging in scientific practices of experime nting	High sense of self; development of scientific knowledge

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #11 03.08	Sophia starts to sing SHINNY from the Disney movie Moana. Maz asks if that song is from the movie.	Home based resources and watching movies	None	None	None	None	Diorama of the coral reef ecosystem	Connection from in school activity to their own home based practices such as watching movies.	High sense of self; connecting science to home practice
CE #12 03.15	Maz brought her own supplies to finish the ecosystem project. This included her own camera she wanted to record with	Home based resources that she wanted to bring over	None	None	Was not recognized for bringing in home materials	None	Camera	Interest in science and participation	High sense of self; increased interest and participation

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #13 04.12	During the filming of the video, Sophia said Maz was wrong and Maz tries to correct herself. Maz also took initiative when editing the video.	None	None	Maz is first recognized as being incorrect. Instead, she tries to become come back and articulate her ideas correctly.	None	Sophia and herself	Video of the ecosystem	Expertise in science and participation	High sense of self; high expertise
CE #14 *04.26	Maz asks what Alondra thinks about the video and says that won't brag. Ms. Paloma also said that it was the one with the most good information	School based resources about information and home based resources such as video production and materials from home	Spanish was used to converse between Maz and Alondra	Recognized as producing strong quality project	None	Ms. Paloma and Alondra	Video of the ecosystem	Expertise in science and participation and project is factually correct	High sense of self; high expertise

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #15 *05.03	Maz comes up with many ideas about ways students can clean up the ocean to solve the problem of pollution	Maz is leveraging home based resources and ideas from using drones from Family Science Night	None		Recognized herself as an expert coming with an idea but nobody recognizes her	Maz recognizes herself for the accomplish ments	Workshe et with the question s about the Engineer ing Design Cycle	Connecti ng home experienc es with Family and to the afterscho ol project	High sense of self; connecting science to home practice
CE #16 05.10	Maz is super excited to be able to build something that helps the environment and she takes on leadership when building the prototype	Home based resources of building and using power tools	Alondra uses Spanish to tell Maz to pick up little parts of the kit they're using	Self recognition as knowing what to do. Maz tells Sophia "no power drills" and "trust me, I know what I am doing."	None	Maz is recognizing herself for her expertise	Blueprin t and prototyp e creations and scientific journal entries	Expertise in science and participat ion and leadershi p in activities	High sense of self; increased interest and participation

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #17 05.24	Maz is starting to build the batteries with her team.	Home based resources such as using power tools	None	Diego says that "our team sucks."	None	Alondra offers to FaceTime her dad to ask about the power drill usage. Alondra counters Diego's claim and says "no it doesn't"	Bicycle prototyp e	Sustained participat ion in activity	High sense of self; increased interest and participation
CE #18 *06.07	Maz gathers the previous worksheets to fill out the engineering design cycle. Then Maz is recognized by Alondra during the awards ceremony.	Home resources and the materials she brought to afterschool	None	Maz was recognized as someone who went above and beyond and brought materials from home. Maz was an overachiever for bringing home materials.	None	Alondra is doing the recognition work publicly in front of Maz's father and other parents and peers	Science medal	Public recogniti on and legitimac y of the year	High sense of self; increased interest and participation

what they learned with the community and classroom. The final culminating project was to create a multimedia project which involved props, a storyboard, crafting a story, and editing.

As part of the project, students learned about the different types of energy around them. Maz's group focused on radio energy and how it is used for communication such as televisions and cellular phones. As part of the process, they conducted background research about their energy of choice, presented it to the after-school peers, and also provided feedback to other groups. The after-school curriculum was centered around thinking about making energy sustainable in whatever context students picked. Moreover, the students were prompted to create some sort of public service announcement to share what they learned about energy and their recommendations for improving community problems concerning energy.

During the activity, Maz worked on the script with her group for their multimedia project, was recognized by Lulu for her effort, and helped her group produce a video about energy in the community. During the script-writing process, Maz tried to use Spanish to write her script but experienced much difficulty and asked Lulu for help.

Maz was able to describe how radio energy could travel long distances in English after clarifying her thoughts in Spanish. Furthermore, as Maz continued to write out the script for her group, Lulu recognized her efforts despite the fact Maz had a difficult time writing earlier. Lulu tells the group she is working with if "they want to help out? *Nomas estoy viendo que* [I'm only seeing that] Maz and Ella are writing down answers." After Maz and Ella finished writing the script, the group quickly practiced their videos and shot their video in one take given the time constraints.

1 Maz: *Se me olvidó* (I forgot).

2 Lulu: *Está bien aver, ¿Tienes una idea te qué se tratabó?* (That's fine

let's see, do you have an idea of what it was about or?)

3 Maz: *Deste* (umm)... It's transport no...U::gh I forgot.

4 Lulu: *Transferir* (transfer).

5 Maz: *Así como este*. (Like that).

6 Lulu: *¿Información?* (information?)

7 Maz: They can go and they can take… *((*Sigh)) *Se me olvidó* (I forgot).

8 Lulu: *¿Tienes una idea de qué se trataba o?* (Do you have an idea of what it was about [the thing she forgot] or?)

9 Maz: *Era un d'este* (It was this uhh) (0.5) ...transport. No. Ah, I forgot. *Transferir, así como, d'este* (transfer, like this um-)

10 Lulu: *¿Informacion*? (Information?) (0.5)

11 Maz: It can travel really long distances.

Through this Critical Event, Maz leveraged her linguistic resources to articulate ideas and communicate in Spanish. Despite having difficulty in actually articulating the idea, Lulu recognized her script writing skills and validating that Maz was working hard and participating. Maz's identity work in this Critical Event shows that she still carried a high sense of self in science and was willing to learn and participate in science-related activities. Maz was positioned as someone hard work and learning, despite gaps in her understanding. She was able to contribute to the script writing as well as act in the video to showcase and highlight her deep participation in science activities. Maz's linguistic resources became identity resources to further engage her in the conversation.

Maz first uses Spanish to clarify her ideas and engage in academic tasks and then switches to English to display her ideas to the larger audience. The switch between Spanish and

English showed how uncertain Maz was about her ideas (Gumperz, 1982). When Maz first used Spanish, she engaged in using language of ideas to advance her academic engagement. When she used English, she engaged in language of displays to articulate her ideas after clarifying them (Bunch, 2014). Previous literature shows that students use multiple languages to form and develop science ideas. Maz was using her multiple languages of Spanish and English to form, develop, and articulate her science ideas. For example, when students are forming ideas in both English and another language, they are leveraging linguistic resources to bear on an academic task (Ryu, 2019). Maz engaged in conversations about academic work, which is described as language of ideas (Bunch, 2014). When Maz engaged in language of ideas, she used conversations to create different types of texts in various languages. In Spanish, Maz had the idea on the tip of her tongue. In multiple instances, she explained that she "[kept] forgetting."

While Maz was forming her idea, she used Spanish to indicate that she was still unpacking and thinking about the idea before formally presenting it to the group. In doing so, she was able to indicate that she needed support from Lulu and her other peers who provided her support in Spanish. Lulu helped her clarify her ideas in Spanish by providing prompts and extending the conversation (Keys, 2000). Eventually, Maz was able to state in English her idea that "it can travel really long distances." Maz then switched over to a language of display, meaning a language designed for consumption and use by other people and the audience (Bunch, 2014). Articulating her idea in English, the language of display, was possible after engaging in the language of ideas and clarifying her thoughts in Spanish. Only when Maz put out her ideas in English was she putting out her ideas about radio waves travelling fast as an official response in the discussion (Ryu, 2019).

Family Time. Maz draws on family time as a cultural resource and practice and is recognized for those efforts. For example, family time blurs with science learning when Maz is talking about her father and volunteering at the food pantry (Critical Event #4), Harry Potter memory experiments with her twin sisters (Critical Event #8), and drone building and engineering design (Critical Event #13). All of these experiences that Maz draws on relate back to the everyday practices she has at home. In addition, her family time eating ice cream at *La Michocana Ice Cream* has supported her identity development toward science as a food chemist. As a food chemist, she plans to ask questions about finding ingredients to make ice cream cold.

Vignette. In Critical Event #4, the students continued with the energy unit. During this unit, students were asked to share what they learned about energy through a video. As a result, the students were also asked to share their recommendations for a problem related to energy in their community. One example was the idea of chemical energy from digesting food. This led to a larger conversation of whether or not all foods are healthy when consuming and digesting food. In order to show a community action, the students interviewed volunteers at the Mercado CBA which focuses on access to healthy food for the local community.

Students were divided into various groups that focused on a specific type of energy. This included groups focusing on kinetic and potential energy, radio energy, and chemical energy. Students created a poster that answered different questions about energy such as describing it and giving examples of the energy. Students presented their poster to the group. After presenting, the educators decided to give another example of energy focusing on radio energy and chemical energy. The lesson revolved around Carlos going to the Mercado CBA and interviewing the manager. The students and the rest of the educators stayed in the classroom and projected a FaceTime session with Carlos. This way, Carlos would be able to walk around and show students the Mercado and also direct live questions from the students to the Mercado manager. Students had guiding questions and were asked to take notes.

During the FaceTime session, Maz was able to bring up her experiences volunteering at Mercado CBA with her dad. One of the points of discussion that the students had was how many people work at the Mercado. The manager stated around five people, mostly volunteers. Students asked can students volunteer and if they would get paid. The manager said that a volunteer needs to be at least eighteen years old, but a parent volunteer can bring a student. Maz said she had volunteered before. Tessa asked Maz to elaborate on her experience since none of the students had ever seen or experienced the Mercado prior to this activity. Maz said "so when people. When I saw my dad help a lot. Those days. When I help. There is a truck coming in and that truck came into the *mercadito* (little market). So then, when they unloaded the food. My dad helps. And then they. Then what happens they start putting food inside the refrigerator and baskets. Once people started to go, there was a lady with a clipboard saying the number. Each person has a different time to go and only have five minutes. So, everyone went they were only allowed to bring two grocery bags. And those two grocery bags you can get as much as you can only in those two grocery bags." Tessa thanked Maz for sharing as she was the only one in the classroom who had inside information about the Mercado.

Identity Work. Through this Critical Event, Maz is positioned and recognized by Tessa as someone with expertise in community-based activities and after-school science learning activities. In particular, volunteering and being with her father at *Mercado CBA* opens an opportunity for Maz to contribute to the discussion of food, energy, and community that no other student has expertise in. Maz even has a strong sense of connection to *CBA* by calling the food pantry *mercadito* (little market). By adding the *-ito* (little) to the end of *Mercado,* Maz is viewing

Mercado CBA in a positive light as something to cherish. Maz's identity work shows a high sense of self as she connects the scientific knowledge of energy and food learned in the after-school program to the family-based volunteering experiences she has. Maz's family-based resources of volunteering at the food pantry are leveraged and recognized by Tessa when she positions Maz as an expert in community-based activities.

Practices and Tools from Home. During the awards ceremony (Critical Event #14), Maz was recognized for bringing materials from home to support her science learning. Maz brings literal materials from home (Critical Event #12) including clay, index cards, and her own camera. Other recognition of home practices includes the food she brings and eating healthy, a concept that was a core of the energy unit. In addition to the family time resources outlined above, Maz starts to blur the lines between science and home and starts seeing connections between these two spaces.

Vignette. In Critical Event #14, as part of the culminating project, groups were asked to gather their previous worksheets, blueprints, and notes to map out their engineering design process. Maz and her group had previously conducted research on an ecosystem they care about: the ocean. As a follow-up to the project, the group was asked to engage in the engineering design process to identify a problem in their ecosystem, develop a solution, test their prototype, and communicate their findings. As a result, Maz's group focused on scooters that generate electrical energy. Their rationale was that protecting the ocean also meant being sustainable overall. On the last day, parents were invited over, and students showcased their engineering projects. The UCI educators prepared a short speech to highlight each groups' accomplishments and close out the academic year.

Maz was the lead of the final project to make a poster about the engineering design process students engaged in. Tessa first went over the task and what was expected from the students: to produce a poster of the engineering design cycle that showcases their intellectual work. With Maz's group, Alondra handed over the previous worksheets that the students made from the previous weeks including blueprints. Maz took the poster and started outlining the engineering design cycle. Maz drew small boxes and Alondra told her *"siento que no va caber asi* (I feel like it won't fit like that)." As Maz got another poster, she redrew the engineering design cycle. Maz said that, "in two years, you'll get my twin sisters in the after-school program. You will be confused by them" as she keeps drawing.

After the students made their posters, they presented them, and Alondra gave a short speech. Parents filled the back of the classroom and greeted each other. Some of the students went to the back of the room and to grab pizza. Maz's father talked up with another mother about how little Maz eats. Alondra asked their group if they want to go first. The students went up with their posters to present. After their presentation, Alondra had medals and made a short speech about her group. Alondra named each of the group members. "They were super dedicated. They would bring materials from home so they could go above and beyond. Maz was an overachiever who would bring materials from home." Alondra translated what she said into Spanish for the audience. After recognizing the students for their work, the students head back to their desks. Ms. Zavala told them "great work" as they walked past her.

Identity Work. In this Critical Event, Maz's resources from home were validated publicly in front of her parents, her peers, and school staff. Furthermore, this recognition of home-based resources legitimized all of her previous ideas that were connected to home including building drones with her family (Critical Event #13, and Critical Event #9). Part of this recognition involved her father hearing it publicly from a college-educated Latina teacher, Alondra. Furthermore, though the interaction was quick, Ms. Zavala also praised Maz and her group. In her identity trajectory, Maz's sense of self was highly stabilized across the year. Her expertise was shown and validated. Finally, Maz was recognized as an overachiever and someone dedicated to learning science as she generates her identity resources.

Case 2: Ali - The Case of When the Highs are Greater than the Lows.

"So, let's all take one more step. We have learned to love ourselves,

so now I urge you to "speak yourself."

– BTS' Kim Nam Jun (RM), UN General Assembly, September 24, 2018.

Ali was a 5th-grade girl who identified ethnically as both El Salvadorian American and Mexican American. Ali was described by her teachers as sweet but misguided. Her parents were divorcing at the time and her sister had a major heart surgery. Despite the stress, they always regard her as positive and happy. There were days in which Ali missed school to be with her sister. Despite missing days, she is always ready to participate in the science afterschool activities. Ali's mother is a tattoo artist. Because of her mom, she is constantly surrounded by art. Ali has a YouTube channel where she uploads home videos that she records and makes with her little sister. During the writing of this dissertation, her YouTube channel has been shut down without any reason. After winter break, Ali started to be an avid fan of BTS and considered herself part of the Army (BTS's fan group). Ali's favorite member is Jungkook and her father would often wake her up in the morning by telling her Jungkook was outside.

Afterschool Experiences. As part of her afterschool experiences, Ali describes it is more fun than school. At the surface level, Ali says in the after-school program, students are able to use posters and colors. Furthermore, in schools, "all we do is research research research research and do nothing with it." When reminded that Ali also conducted research as well in the after-school program, Ali says, "but in school, we just research and that's it." So, are you researching to learn? Is that what you do in afterschool then?" I ask her. "But we're using! We use the poster to be smart!"

The after-school setting was not only a space for Ali to engage in science discourses and practices but also a space where she became accepted. For example, as a fan of BTS, Ali had difficulty finding her interests and home practices as legitimate and popular. In fact, many of her peers in the after-school space teased Ali for her K-pop following, said K-pop "is not cool" and excluded her from the group. However, Lulu was also an avid fan of K-pop and BTS in particular. Lulu legitimized Ali's interest in BTS. Lulu defended and stood up for Ali when Ali was being bullied by her other groupmates. Lulu also openly talked about BTS with Ali and even allowed her to play BTS music during group work time.

School Experiences. As part of her school experiences, Ali struggled academically and has difficulty connecting to the material. As an artist, Ali was looking for opportunities to express herself. When asked if she does a lot of drawing in class, Ali said she was "bored of what we're learning" in class. She joked and pretended to be a teacher, "okay guys, this is the digestive system in your stomach." Ali made a face and continued to impersonate a teacher, "blah blah blah."

Positioning Self. At the beginning of the year (12/6/17) Ali took a survey and indicated medium interest in science and engagement in a few science activities at home. As a future science career, Ali stated that she had high interest in computer and engineering-related jobs. Toward the end of the year (6/1/18), Ali's interest in science grew according to her survey. She began to engage more in science activities at home and expressed a continued high interest in a computer-related field.

Positioned by Teachers. Academically, all of her teachers indicated that she struggles. Assignments were either incomplete or done wrong, most likely due to being rushed. All her teachers describe Ali as an artist, just like her mother. Mrs. Garcia, her ELA/Spanish/Social Studies teacher even mentioned that Ali drew a picture of Mrs. Garcia and entered it in an art contest. Mrs. Garcia thought it was the kindest and most thoughtful surprise from a student. Mrs. Garcia even took time out of her schedule to see the portrait on display and framed the photo on her desk.

Summary of Ali - The Case of When the Highs are Greater than the Lows

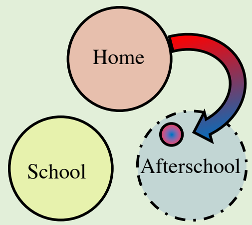
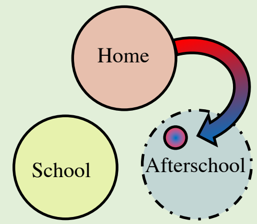
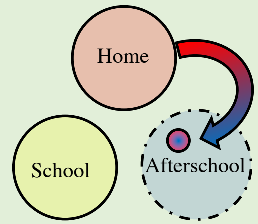
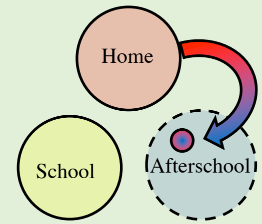
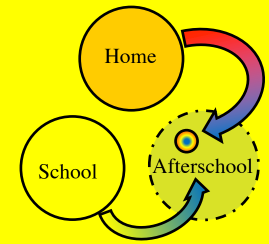
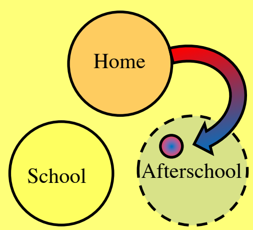
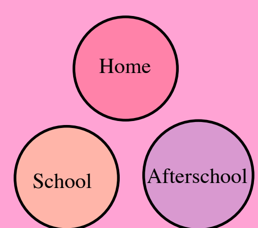
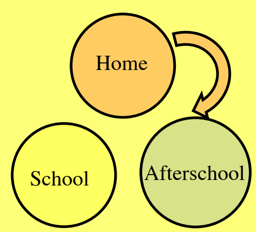
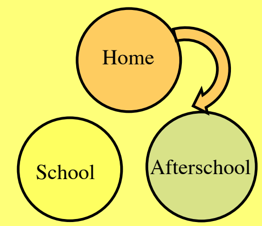
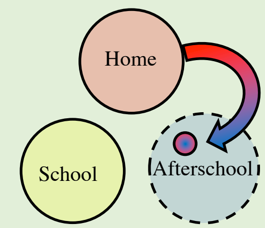
The Case of Ali across her Identity Heat Maps (see Figure 4.1) shows a mix of high and low sense of self across all Critical Events. There were times when Ali's participation was recognized by others as productive and insightful. There were even moments when Ali recognized herself and her own accomplishments. However, there were also moments in which Ali's participation was delegitimized and unrecognized as being productive as well. From the Critical Events, three consistent patterns arose: Ali's use of counterspace for learning, leveraging bonding time with Lulu, and practices and tools traveling from home to generate identity resources and gain momentum as she goes from the highs to the lows of her identity work.

Overall, Ali's pattern of participation and engagement in the after-school program was uneven. She started off high, destabilized away from a sense of self in science, a sense of self not in science, high participation destabilized away from a sense of self in science, and ended with high participation in science. In other words, Ali experienced varying highs and lows in her after-school experiences. The fifteen events (see Table 5.2) of Ali showed varying connections of home and school practices in the after-school science activities as well as moments of when she was recognized for her expertise in science and moments where her science expertise was delegitimized by peers.

Ali exemplifies a case of when the highs are greater than the low because, at many Critical Events, she was destabilized and delegitimized as both a BTS fan and a science person. In many attempts, other peers made fun of her interests in BTS and even verbally and socially bullied her. Yet, Ali still strove to self-recognize her accomplishments and participate in activities. An undergraduate research assistant, Lulu, who shared her K-pop interest, supported Ali in carving a space in the after-school program by validating and legitimizing Ali's interests in BTS. Those moments of being recognized, being understood, and finding her place (as a BTS fan and a science minded person), became high points. The high point, the various social interaction and engagements of self-love despite the words from others, were much greater than the lows.

To better understand how Ali generated identity resources, I combined the conceptual framework of identity resources (Figure 3.1), the Identity Heat Map (Figure 4.1), and the Critical Events table (Table 5.2). Creating Ali's Generated Identity Resources (Figure 5.2) helps us to understand how resources were leveraged and recognized, how identity resources were generated, and how generating identity resources was tied to Ali's STEM engagement.

Counter-space for Learning. Through Ali, we see that the after-school setting became a counter-space for Ali to thrive, engage with, and excel in STEM learning experiences. Ali's own description of her participation was quite different than what the teachers described. The teachers we interviewed often described Ali as struggling in classes. This was further complicated in Ali's discussion about school science and after-school science (Critical Event #4). As Ali stated, after

Critical Event #1	Critical Event #2	Critical Event #3	Critical Event #4	Critical Event #5
				
Event: Subway sandwiches Resource: Food Recognition: Self Identity Resource: Subway sandwiches:	Event: PowerPoint Resource: Technology Recognition: Tessa and David Identity Resource: Technology resources:	Event: Booklet about energy Resource: Art and technology Recognition: Lulu/Self Identity Resource: Art and technology:	Event: Presenting Resource: Art and bread Recognition: Self/Lulu Identity Resource: Art making resources and Sandwiches/food:	Event: Mercado Essay Resource: Writing and drawing resources Recognition: A classmate Identity Resource: Writing and drawing.
Critical Event #6	Critical Event #7	Critical Event #8	Critical Event #9	Critical Event #10
				
Event: Soda Commercial Resource: Drawing and acting Recognition: Self Identity Resource: Writing and drawing:	Event: Ecosystem video Resource: N/A Recognition: Pedro as not understanding the activity Identity Resource: N/A	Event: Editing videos Resource: Technology and editing videos Recognition: Not contributing or a good editor Identity Resource: N/A	Event: Drawing posters Resource: Poster drawing and art skills Recognition: Not part of the group Identity Resource: N/A	Event: Show and tell Resource: Video games and coding Recognition: Self, teacher, and peer Identity Resource: Technology and coding

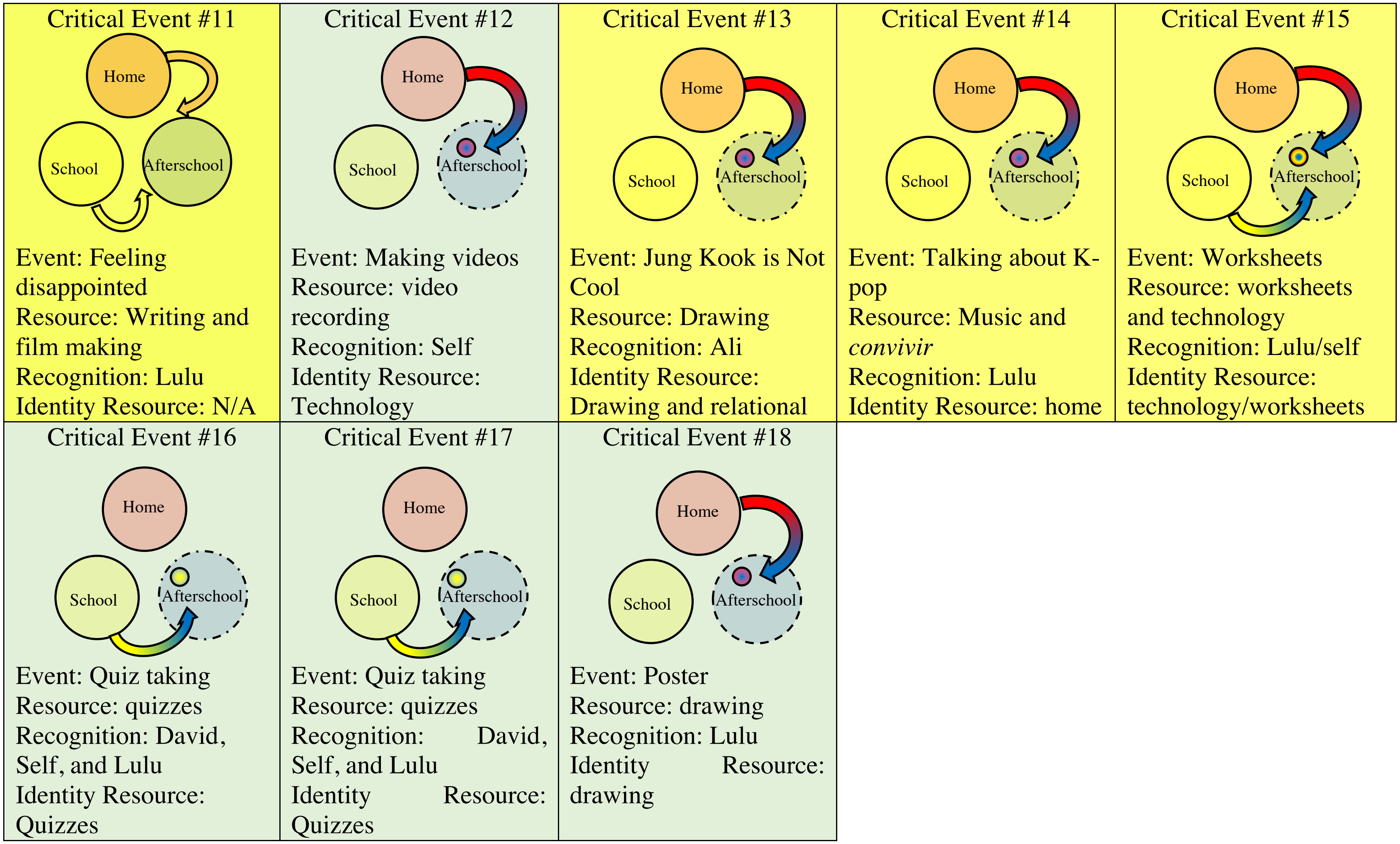


Figure 5.2. Ali's Generated Identity Resources

Note. More information about the Critical Event is found on Table 5.2.

Identity Heat Map: Green = sense of self in science, destabilization: Blue = toward sense of self in science, Yellow = destabilization: toward sense of self away from science, Red = sense of self not in science.

Table 5.2. Events for Ali (Starred Events are Critical Events [CE] Written in the Findings)

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #1 *10.19	Ali talks about the ingredients made of Subway turkey sandwiches and how she didn't realize it was made of sugar and masa (dough)	Home cooking practices and bread making	Masa (dough) was used to be able to talk about ingredients	Able to present to the classroom and share what she learned	None	Self	Outline of foods and ingredients	Interests in science	High sense of self in science and connections to home such as food
CE #2 11.02	Ali is the only girl who created a PowerPoint and she talks about her YouTube channel	Home based technology resources and YouTube resources	None	David recognizes Ali as tech savvy. Tessa acknowledges the work that Ali did.	None	Tessa and David	Science and Me PowerPoint	Legitimization of Home based technology practices	High sense of self in science and connections to home such as technology

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #3 *11.09	Ali loves to talk about technology and talks about her YouTube channel and her PowerPoint Ali was recognized for bringing something organize like humans consume energy. After, she says she wants to make a booklet about energy.	Art and technolog y based resources from the home setting	None	Lulu recognizes Ali for bringing something different to the conversation. Ali smiles when Lulu publicly recognizes her in the large classroom conversation. During the talk about animations, she showcases her expertise in the software she uses for her 3D animations.	Lulu's recognition (classwork/co nversation), Class recognition (via Lulu's presenting), Self-positioning (technology/vi deo)	None	Lulu and Self		Interest in science, change is participation of science and engaging in scientific ideas of digestion and energy consumption

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #4 *11.16	During the presentation, Ali describes the chemical reactions in bread and tries to cut in during another boy's presentation. She also says afterschool posters make her feel smart. she talks about the science behind the chemical reactions in bread.	Home based resources such as eating Subway sandwiches and drawing and poster making resources	None	Positioned as an expert knower that knows a lot of scientific information and positioned as an artist	Self	None	Self when she tries and cuts in during the presentation. Lulu recognizes Ali for knowing a lot about how bread works but this is heard in passing	PowerPoint presentations and posters about the process of energy consumption	Interest in science as it relates to cooking, feeling smart specially in afterschool settings, and art related interests in communicating science

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #5 11.30	Ali thinks that Zoe called her rude, when presenting one of the boys says bravo, and during the FaceTime activity, Ali writes really loudly and writes a long paper about the experiences of the Mercado	Drawing resources and writing resources	None	Ali is positioning herself incorrectly as someone who is rude and is gaining some recognition for the poster work	Not recognized for the paper that she wrote answering and documenting all the questions from the FaceTime activity.	A boy was recognizing the poster work but nobody recognized her for her paper that she wrote from the FaceTime activity	Ali wrote a long 5 page paper answeri ng all the questio ns and keeping a record of the comme nts of the FaceTi me convers ations	Ali learned more about healthy and unhealthy foods as well as more about local resources such as the Mercado	Unrecognized accomplishme nts when engaging in science

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #6 *12.07	Ali makes a commercial about soda. She draws the props for it and many people try to throw away her materials. Many of the students also say that Ali is taking their project and "ruining it."	Drawing and acting resources	None	Ali is recognized as someone who is ruining the project and many students are undermine an opportunity for engaging in the project.	Ali is not recognized as someone who is contributing but is always trying to redirect the comments and stands her ground, even when other students try to take her ideas.	Ali is doing her own recognition work when she tells Morgan no when he tries to recreate and take her idea	Props that she drew includi ng microp hone and the advertis ement of sodas	Learning more about energy and healthy and unhealthy food	Instability; other student tries and prevent her from engaging but Ali finds ways to participate

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #7 *01.25	During the ecosystem video, Ali says she does not understand the activity. Pedro describes that it's a watching game and Ali is confused	None	None	Positioned as someone who doesn't understand the learning activity	Not recognized for trying or being able to contribute, positioned learning as a game	Pedro is recognizing her publicly for not understanding the game	Worksheet on key terms of the ecosystem	Less expertise in science and participation in activities.	Destabilized sense of self in science where Ali does not understand what is happening

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #8 02.01	Ali keeps saying she wants to edit the videos on iMovie but everyone keeps telling her no and even says that she is a troublemaker.	Technology based resources	None	Ali is positioned as someone who is not allowed in the group and is uncapable of doing the work for the group	None	Pedro and Ella are positioning Ali as not contributing and not a good editor. Ali also tries to gain her own recognition and positioning herself as expert.	Worksheets	Ali tries to position herself as an expert but is denied opportunities to show her performance as an expert in technology.	Instability; other student tries and prevent her from engaging and Ali is denied experiences to leverage her technology based resources.

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #9 02.15	Ali publicly mentions that she wants to change groups. Other students are not happy with the drawings that Ali is making and her use of other people's markers. Ali mentions that other people are trying to ruin her drawing and Pedro also took away the poster from her hands. Ella won't let Ali flip the poster over to add her feedback. Ali has to use another sheet of paper to continue to draw.	Drawing resources and poster making resources	None	Ali is recognized as her drawings not contributin g to the group work and ruining the project. Ali is also positioning herself as someone who does not fit into the group	None	Ali is recognizing that she is not a part of the group, her peers are also recognizing that her drawing is not helpful for the project	Poster drawing s that were erased and the drawing s she drew on another piece of paper	Less interest in science	Instabilit y; Ali mentione d not being able to participat e in her group and is getting bullied therefore decreasin g her participat ion.

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #10 02.22	Presented video app and her coded story to the group. Ali says coding is easy and there are different ways to code.	Home based resources to talk about coding practices and technolog y use	None	Recognized self as an expert about technology and coding. Franny positioned her as an expert saying that she is going to make an animation.	None	Self-recognition, teacher recognition, and peer recognition	Animat ion she created	More interest in science and public presentati on.	High interest in coding that is publicly displayed and legitimized
CE #11 03.01	Ali says she feels disappointe d in her teammates for goofing off and is helping with the script and writing.	Writing and film making home based resources	None	Ali positions herself as someone who contributes a lot but is not recognized by others	None	Lulu validates how Ali feels about the contribution of her teammates to the project	Script writing	Validatio n that the group dynamics is not conduciv e to Ali's learning.	Instability; has high sense of self but is not recognized by others

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #12 04.12	Ali says she can show the other students how to tri the video for recording.	Technology based resources from home'	None	Ali is recognized as a film editor for the group	None	Ali recognizes herself	Edited videos	Participation in science related activities	High sense of self and participation in science activities
CE #13 05.03	Pedro defaces Ali's poster writing that "Jung-Kook is not cool." Ella gives Ali a few dismissive gestures when she talks about K-pop. Lulu and Ali talk more about K-pop.	Home based resources such as drawing and listening to K-pop	None	Positioned as someone weird and whose interests are not aligned with the norms of the group. Then Lulu was able to talk about how she is also interested in the same things Ali is	None	Peers are recognizing her as someone who does not belong. Lulu validates Ali's interest in K-pop as legitimate	Poster with Pedro defacing the poster. Paper with the Engineering Design questions that Ali is writing on and fighting back and forth	Invalidation of interests, change in participation, and then validation of interests and peers bullying her.	Instability; being bullied and low participation and is told she is not belonging until validated by teachers

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #14 *05.10	Ali is being told she doesn't fit in and other students take away her supplies and materials. During the group conversation of prototypes, Ali offers ideas. Lulu talks about K-pop to Ali. Ella and Pedro try to take away more materials from Ali	Home based resources such as family time and BBQ, K-pop listening, and using objects found at home	Ali says using *chappitas* (metal cap/hinge) for a lid of the fire pit. She also swears at Pedro in Spanish.	Ali is recognized for her intellectual work by Lulu. Lulu also affirms her interest in K-pop. The other students, Pedro and Ella, try to take away the laptop from her and turn off the phone that is playing K-pop music	None	Lulu is recognizing K-pop interests and intellectual contributions. Ella and Pedro are recognizing her as not part of the group	Ali had the poster working on her blue prints	Invalidation of interests from peers, validation from Lulu. Group members prevent her participation	Instability; being bullied and low participation and is told she is not belonging until validated by teachers

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #15 05.17	Ali interjects her ideas but are dismissed by her peers. Her peers are reluctant to share any materials. Ali then creates a worksheet on the computer to keep her team accountable	Home resources such as technology and school based resources such as worksheets	None	Ali is dismissed for her intellectual ideas and she tries to contribute. Since Ali was not able to gain recognition for her contribution, she created another worksheet to express what she knows.	Missed opportunity for her drawing contributions	Her peers are recognizing her as not contributing. Lulu is recognizing Ali's work on her worksheet as contributing	Worksheet that Ali made on Lulu's computer	Invalidation of contribution, increased participation in another science based activity	Instability; being bullied and low participation and is told she is not belonging until validated by teachers. Creates another opportunity to stabilize her participation in science

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #16 05.24	Ali talks about giving the worksheet to her entire group. Maz asks if Ali typed up the worksheet all by herself. Lulu asks the other students to look at the new document that Ali made.	School based resources such as quiz taking	None	The quizzes and the worksheets are taken seriously by David and he said he will print them out. Lulu states that Ali did the worksheet all by herself. Zoe says good job. Lulu also said that Ali made a prototype of the worksheet firs and she loves Ali's enthusiasm.	None	David is doing the recognition work and legitimizing Ali's interests and her endeavors. Lulu is validating Ali's worksheet as independent. Lulu also mentions that Ali's work is aligned with the goals of the engineering design cycle.	Printing out Ali's quizzes and her workshe ets	Legitimizat ion of Ali's intellectual work and making connection s to engineering design cycle.	High sense of self; positioned and recognized for science contributio ns

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #17 *05.31	Ali made her quiz to give to her group mates. Ali said she made the quiz because she was bored and wanted to help her group. Ella says that Ali's quiz is not good. Lulu says her worksheets are beautiful. Ali says she is proud of her quiz. Lulu also asks Pedro what he has against BTS. Lulu also gives Ali a hug before the class session ends and talks about the BTS concert.	School based resources such as quiz taking	None	Ali tries to position herself as someone with someone knowledge and takes pride in her creation. Ella tries to delegitimiz e her quiz. Lulu also recognizes Ali's interest in BTS and tells her she reminds her of herself.	None	Lulu is legitimizing Ali's interest despite it being unaccepted in the group, Ella and Zoe try to disregard the work Ali put in making the quiz and worksheets. Ali also recognizes herself for completing the quiz and taking pride of it. Lulu says that the worksheet is beautiful.	Quiz that was printed and other student s took	Sense of pride in learning, sense of connectio n with Lulu, and gaining legitimac y in the afterscho ol group.	High sense of self; legitima cy and creating own ways of participa tion

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #18 06.07	Ali is working on the poster and Pedro says the poster is his. Ali gets another poster and starts drawing on it. Ali then says her dad is confused about what they're doing. Lulu suggests translating it to her dad and practicing her Spanish	Drawing home based resources.	Lulu suggests that Ali keep working on her Spanish to be able to communicate with her dad.	Recognized as someone with a great future in the presentations. Recognized for her thank you poster that was left on the wall that was signed by everyone.	Not recognized for her contribution to the engineering design cycle poster.	Lulu is doing the recognition work	Poster of engineering design cycle and medal	Legitimacy of Spanish and legitimacy of their contributions to the year	High sense of self; legitimacy and creating own ways of participation

school, she draws posters to feel smart. In comparison to during school, Ali feels that all they do is research and do nothing about it. Therefore, the after-school program became a counter-space for Ali to participate successfully in STEM activities. Through her participation, Ali challenges what traditional STEM learning looks like. Instead of simply being a recipient of STEM knowledge, Ali fashioned new ways of engaging in STEM activities.

When the counterspace of the after-school program had similar rules and norms of school, Ali's participation and engagement fell. For example, when watching the ecosystem video, Ali was asked to engage with science using very school-based norms and rules including a decontextualized video of ecosystems and knowledge (Critical Event #7). However, Ali attempted to flip the power dynamics of the classroom by introducing school-based practices such as worksheets and quizzes that she created (Critical Event #16 and 17). Through this, Ali positioned herself as an expert in terms of science domain knowledge within her group.

Furthermore, Ali positioned herself as someone capable of succeeding in science by keeping her groupmates accountable. Again, there were multiple instances in which Ali did not feel like she belonged with her group. Her groupmates consistently positioned her as a non-expert in technology and science (Critical Event #7). Furthermore, many of her groupmates challenged her interests in BTS and K-pop, thereby delegitimizing Ali's counter-space (Critical Event #14). Yet, Ali followed the message of BTS to find self-love and express herself authentically. This is important to Ali because as a counter-space, the after-school setting not only supported rich academic engagement and hybrid practices, but also became a space where she could be herself.

The after-school program became a space for Ali to be herself following the BTS message of the "LOVE MYSELF" campaign (Leung, 2019). The BTS LOVE MYSELF campaign is an anti-violence campaign in partnership with the Korean and Japan Committee for UNICEF prompting young people to post self-loving photos using #BTSLoveMyself (Herman, 2018). This idea of self-love and individuality emerges as Ali continuously rose up; even when her peers tried to drag her down and make fun of her.

Vignette. In Critical Event #16, Ali made a worksheet similar to those the UCI educators made for the students to keep them accountable. Ali used Lulu's computer to create the worksheet and spent a majority of the time making the worksheet. She considered making that worksheet her "break." Lulu said she was looking forward to what Ali came up with next. During our weekly planning meeting after Critical Event #16, Lulu told me that Ali made something very impressive on her computer during the session. I suggested that Lulu print it out for Ali so that she could share with her teammates.

Lulu started to read from the worksheet as Ali jumped up and down in excitement. Zoe looked annoyed when Lulu started reading the worksheet that she made. Zoe asked Lulu if Ali typed the work sheet herself. "Yes, she did" Lulu responded. "Did she have any help from you?" Zoe asked. "Nope. She did it all by herself," Lulu said. "Good job," Zoe said before smiling at Ali. After Lulu read Ali's worksheet, Lulu told the group that they need to understand the science behind the project. Ali grabbed the laptop again and started opening a Word Document to create another worksheet. After about half an hour, Ali said she made a quiz for her group.

Lulu said she found it interesting that Ali is worried even though she was not grading the quiz. Lulu passed out the worksheet to Ali's group. The students looked nervous. Lulu said, "I find it interesting how you guys are worried about grades but you're not getting graded in this class" as she looked at Ali's worksheet. Ali continued to work on the computer. During the course of the hour, she made a quiz based on the core concepts of their engineering project:

engineering design and forest fires. Ali asked me if I could print out the quiz she made. "The worksheet is four pages and the quiz are one page," she reminded me. Lulu explained to another student that she is looking at Ali's final worksheet because her first one was a prototype. Lulu said, "we should make a good product and get a good grade, 100/100." Lulu said she loved the enthusiasm from the students. After the break, Ali kept working on the laptop to finish the quiz.

Identity Work. In this Critical Event, Ali created a worksheet that draws from her school-based practices such as worksheets and quizzes. For the longest time, Ali was having difficulty finding a role to participate in and engage with the after-school activity. In other Critical Events, Ali had difficulty engaging because she was denied opportunities to participate (see Critical Event #6). She did not gain recognition in various activities such as the watching game and in many other activities and did not have a specific role in the group. Therefore, Ali started to make the worksheet and the quizzes to keep her group accountable for the work they were doing, both in terms of engineering design and the science of fires. She created an artifact that resembled school-based practices: a worksheet and a quiz. Lulu recognized the worksheet and the artifact giving Ali full recognition and ownership.

Zoe, another student, recognized Ali for her accomplishments in making the worksheet, by being surprised that Ali created it all by herself. In a way, Ali was challenging and mocking school-based practices and asserting her own practices in the after-school program to keep her team accountable and to participate in STEM activities. By creating the quiz and the worksheet, Ali was also demonstrating her own expertise in STEM, highlighting what her teammates should know to be successful in the activity. In terms of her positioning, Ali was positioned as someone who was engaging in engineering design by creating a prototype of the worksheet. In terms of her identity work, Ali previously had difficulty finding her own ways to engage in the STEM activities. By creating the worksheet and quiz artifact, Ali was able to leverage school practices and be recognized for it by Lulu and Zoe. Ali's participation in the activity increased by exerting her own agency to carve out another way to participate and engage in prototyping a new product: her worksheet, quiz, and identity resources.

Bonding Time (*convivir*). Because the after-school setting became a counter-space for Ali, she was able to participate in and engage with a home-based practice not normally accessible in school environments: K-pop. Ali, a fan of BTS, caught onto the BTS craze. In every possible moment, she would describe a new song and talk about her favorite member, Jung-Kook. However, not many of her peers shared this interest. At one point, one of her group mates tagged her poster with "Jun-Kook is not cool" (see Critical Event #14). The afterschool, a counter-space, allowed Ali to be herself as an artist, a science person, and a BTS Fan, even when she was rejected and delegitimized by her peers. However, within this counter-space, educators were able to be themselves as well and legitimized Ali's interest in K-pop even when others did not. Lulu created moments of bonding with Ali and K-pop by allowing her to not only talk about BTS but also play music in the afterschool setting while working. This became important as someone who was constantly rejected. Ali was able to carve a place within the counter-space of the after-school program with the help of Lulu. Ali could be herself: a Latina who engaged deeply in science, was a loyal fan of K-pop, and was deeply involved in and engaged with technology.

Vignette. In Critical Event #14, students were working on their *Science and Me* presentations. This *Science and Me* project occurred after many times of being socially excluded due to Ali's interests in BTS. At the end of the presentation, students began to brainstorm ideas for the Engineering Unit. In the engineering unit, students selected a problem in their ecosystem video and designed a solution for it.

For her *Science and Me*, Ali decided to make a poster. As part of her poster, she described what science means to her and her positive experiences with science. By this time, Ali had become a big fan of BTS and would discuss BTS whenever she could. At one point, Ali argued with Pedro about one of the BTS members, Jung-kook. Ali expressed excitement to see him in May of the current year the Los Angeles concert. Ali continued to work on her paper and continues to talk about BTS.

Ali said "I will marry Jung-Kook" to Zoe and Ella. Ella said, "she's going to marry him." Zoe said "who" and Ella responded, "whatever she's talking about." Zoe was at first confused then said, "oh, her Korean crush." As Ali had this conversation with Ella and Zoe, on the corner of her *Science and Me* poster, Pedro wrote in large words, "Jung-Kook is not cool." Ali looked enraged and grabbed at Pedro's poster. "That's mean," Zoe said to Ali. "It's because Pedro wrote that Jung-kook is not cool" Ali responded. Ali looked back at Pedro and stared him down, "Never talk about my Jung-kook again." After presenting their posters to the class, the entire group sat down to discuss their engineering solution.

Lulu went around the table and asked each of the students about their ideas for their solution to their ecosystem problem. Ali, off topic, responded back to Lulu saying, "J. Hope is beautiful." Ella asked who J. Hope is and Lulu said he's a singer in BTS. Ella made a comment that she "doesn't know who he is." Lulu said, "it's ok, everyone has their own interests." Ali then interjected to say she has 151 photos saved in her photo gallery and Ella made a surprised face. Over the course of 10 minutes or so, Lulu and Ali talked about K-pop before wrapping up the brainstorm session of the engineering unit.

Identity Work. In this Critical Event, Ali expressed her interests in BTS and tagged it onto her *Science and Me* poster to share her identity as both a science person and a fan of BTS. The cultural resources that Ali drew on included her drawing resources (to make the poster) and some of her own practices of listening to BTS. BTS did not directly support her in learning science. However, her interest was still leveraged as an important cultural resource and practice that needed to be recognized especially since Ali brought that part of herself into her STEM meaning making. Zoe, Ella, and Pedro unfairly made fun of Ali's interests of BTS. In a way, this recognition of BTS as apart from mainstream culture destabilized Ali beyond being a science person but also as a person. However, Lulu's acknowledgement of BTS restabilized Ali's identity as a BTS fan. Furthermore, Lulu was able to challenge Pedro's notions of what is acceptable or not in terms of personal interests. Because Lulu legitimized BTS in the learning space, Ali was able to talk about her interests in this setting. Again, BTS was not directly a cultural resource in STEM learning. However, having this interest legitimized as a cultural practice of Ali's, opened the space for Ali to learn.

Practices and Tools from Home. Ali leveraged many of her home and school resources including food items and technology-based practices. For example, Ali was able to make connections to home practices of making bread with *masa* (flour) and Subway Sandwiches (Critical Event #1). In addition, Ali discussed many more of her school-based practices of eating school lunches where she makes the connections to the lunches and chemical energy (Critical Event #3). Another critical identity resource that Ali leveraged over time was her technology-based resources, which she used to edit and make videos and PowerPoints. In these instances, Ali was recognized for engaging in technology-based practices to make media artifacts.

Vignette. In Critical Event #1, Ali showed connections between her home and afterschool practices, particularly when it came to baking bread and eating Subway turkey sandwiches. This was the first activity of the year, right after a "getting to know you" activity between the research assistants and CBA students. Her interest in science can be seen in the Kitchen Chemistry activity where she looked up YouTube videos of how to make bread and mayonnaise.

As part of the activity, students were asked to select their favorite food and look up the ingredients that made that food. Ali said that her favorite food was Subway turkey sandwiches on white bread when prompted. iPads were then passed around and Ali and Maz started to look up YouTube video recipes for mayonnaise. Ali and Maz searched for more recipes before Tessa and Lulu called for the classroom's attention. Tessa asks for students to share what they found.

Ali became super eager and excited to share. She made sounds to catch Tessa's attention and propped herself up. When Ali was finally called, she shared that she "originally thought that bread was made out of *masa* (dough made from maize flour), flour, and water." Ali enthusiastically started to list out the recipe she found, including the ingredients and all the measurements for each. Tessa asks if Ali was surprised by any of the ingredients. "I didn't know how much sugar there was compared to salt" Ali responded. Tessa then moved onto the next student, Maz, who shared the recipe for chicken teriyaki sauce. Tessa asked Maz if anything surprised her. Maz said sugar. Ali, immediately and assertively, said "it's obvious since teriyaki is sweet."

Identity Work. In this Critical Event, Ali made connections from her home practices, such as eating turkey sandwiches, and demonstrated her expertise in food. Ali was able to engage in the science activity, breaking down a turkey sandwich into its ingredients. Ali also made the connection between *masa* and these sandwiches, describing her misconceptions of what the bread was made of and how she had learned a new idea. Furthermore, throughout the discussion, Ali enthusiastically sought Tessa's attention. Ali was self-recognizing her contribution by sharing what she learned about the amount of sugar in the bread. Later, when Maz was sharing the recipe for the teriyaki sauce, Ali positioned herself as an expert because Maz's observation and claim was "obvious" to Ali. Ali's identity work showed high engagement in science and was supported by her own engagement in the activity and self-positioning as an expert. Her home practices (e.g., eating Subway turkey sandwiches) and expertise in food were recognized and generated identity resources.

Case 3: Ella - The Case of Finding Her Voice.

"Everyone seemed to fit in, except for me. I look back on the discomfort of that moment now and recognize the more universal challenge of squaring who you are with where you come from and where you want to go.

I also realize that I was a long way, still, from finding my voice."

– Michelle Obama, Becoming.

Ella identifies her ethnicity as both Mexican and Tongva, a Native American group in Orange County. During her interviews (5/10/18, 5/31/18), Ella described Tongva traditions such as participating in powwow gathering circles, "Indian dance parties", developing a Tongva accent, learning how to hunt for food, and camping outdoors. She was very involved with her Tongva community, often spending weekends with them and participating in group events. She also camped often with her family and local community. Teachers often describe that she is close with her Native American community. However, not much is known about that side by her teachers. Many of the teachers say not she does not discuss much of her Native American heritage. Through the interviews as well, Ella was relatively silent about her Native American background. Ella liked to use Snapchat a lot and used mobile devices. She would often Snapchat in order to keep up with her friends and family. She also spends time with her immediate family such as going to the California Science Center. Her mom worked selling cars while her dad washed cars. Ella stated she wants to help people and become a doctor.

After-School Experiences. When asked to describe the experiences of the after-school program, Ella had quite positive views. She said she “learned stuff they don’t know like forest and how to make it better.” When asked why it was important, Ella agrees that it is because her family goes camping a lot.

Yet, when observing Ella, there seemed to be quite a different story. There were multiple times when Ella was seen not engaging, sitting quietly, and being told that she was not contributing and should contribute more. In a few instances, many positioned Ella as someone who was not doing anything. In many instances, when Ella did try to participate; it backfired. Either people tried to show up he contribution or did not see her contribution as significant.

School Experiences. Overall, teachers described Ella as needing motivation and self-confidence. Though they said she academically struggles sometimes, Ella was not afraid to approach the teachers when she needed the support. Over the course of the year, they noticed that she became more talkative and friendly with her teachers. Otherwise, many of the teachers did not have much to say about her. It seems like Ella was lost in the middle.

Positioning Self. At the beginning of the year (12/6/17), Ella indicated on her survey that she had high interests in science, engaged with many science activities in science, and checked only a few boxes for an interest in a science career. She indicated that her science grades were average. On the year end survey (6/1/18), Ella’s interest in science and home activities in science remained quite high. However, one significant change occurred when she saw how high her grades were. At the end of the year, Ella rated herself “3 out of 4” as someone who can do science. She said that she “doesn’t really know a lot of science stuff but she knows she is good with medium (sic) kind of stuff.” Ella did state that people did not recognize her for being good at science, only being good at soccer.

Summary of Ella: Case of Finding Her Voice

The Case of Ella across her Identity Heat Maps (see Figure 4.1) showed a consistently low sense of self across all Critical Events. There were times when Ella’s participation was recognized by others as productive and insightful toward the end of the activities. Yet, for the most part, Ella was consistently recognized and positioned as someone who was not contributing to the group. As Ella continued to strive toward participating and there were several moments in which she was recognized for her contributions.

Yet, her contributions were too little and too late in the observation period. After being positioned as not participating, Ella’s engagement increased only at the end of the observations. Because of this Ella, quickly lost momentum after each Critical Event and was unable to fully participate and be recognized for her contributions. From these Critical Events, two consistent patterns arose. The first was the counter-space in which Ella was recognized as not contributing to the group work. Ella created her own counter-space by drawing on the white board and creating flowers out of the materials. Second, bilingual resources were leveraged after she was positioned and recognized as not contributing to the group in order to better support her engagement in the group.

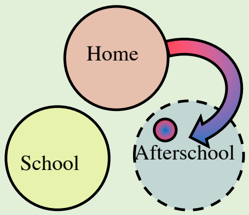
Ella was still finding her voice as someone who willing to contribute; she wanted to contribute but did not have the opportunity. There were many instances in which she was trying to participate in activities, but her contributions were not recognized. Vying for recognition, Ella engaged in activities that drew attention to the fact that she was not participating, such as drawing on the white board. When it was recognized that Ella did not have a task, she was assigned to one. Ella was able to deeply engage in STEM activities, yet the timing was too late for her to be recognized for her STEM participation and accomplishments.

Overall, Ella's pattern of participation and engagement in the after-school program started off low and remained low. Out of the total seventeen Critical Events (see Table 5.3) observed with Ella, two of the Critical Events did show high engagement and participation in the activities. In the counter-space of the after-school setting, Ella had difficulty being recognized for her STEM accomplishments. In many cases, Ella was positioned as *not* a STEM expert when others positioned themselves as STEM experts.

To better understand how Ella's generated identity resources, I combined the conceptual framework of identity resources (Figure 3.1), the Identity Heat Map (Figure 4.1), and the Critical Events table (Table 5.3). Creating Ella's Generated Identity Resources (Figure 5.3) helped us understand how resources were leveraged, if it was recognized, how identity resources were generated, and how generating identity resources was tied to Ella's STEM engagement.

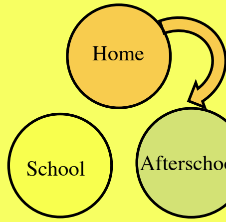
Counter-Spaces. The after-school program became a counter-space for Ella to participate in and engage with STEM at varying degrees. The after-school counter-space also became a setting for her to find ways to *not* participate, and thus claim exclusion from her peers. By doing so, she was drawing attention to the fact that she had no tasks and thus vying for opportunities to engage with STEM. Ella countered many of the dominant norms of what it means to participate in STEM activities and to be resilient and find one's voice. In typical school environments, if a student were off task, they would be reprimanded. In the case of Ella, when she was off task, she was assigned to new roles and new ways to participate in activities.

Critical Event #1



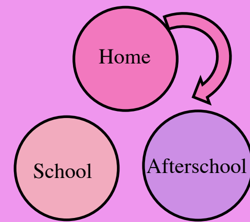
Event: Recipe Activity
Resource: Cooking and Spanish
Recognition: Lulu
Identity Resource: Cooking and Spanish

Critical Event #2



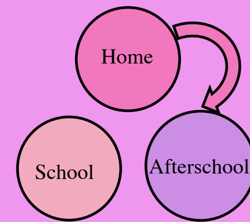
Event: Cutting off from presenting
Resource: TV watching
Recognition: Maz and Pedro as not participating
Identity Resource: N/A

Critical Event #3



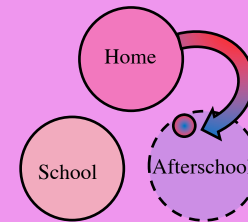
Event: Doesn't Care
Resource: Spanish and TV Watching
Recognition: Caleb as someone not participating
Identity Resource: N/A

Critical Event #4



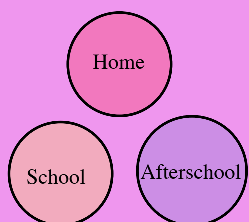
Event: Flip phones
Resource: Phones at home usage
Recognition: Tessa
Identity Resource: N/A

Critical Event #5



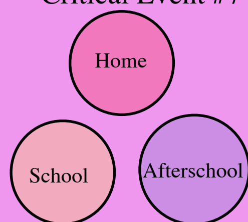
Event: Is Grass Living?
Resource: Playing soccer
Recognition: Tessa
Identity Resource: Grass and soccer resources

Critical Event #6



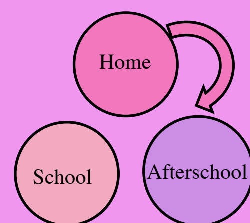
Event: iPad research
Resource: N/A
Recognition: Maz recognizes Ella as not contributing
Identity Resource: N/A

Critical Event #7



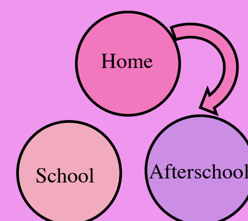
Event: Not working hard
Resource: N/A
Recognition: Pedro recognizes Ella as not working hard
Identity Resource: N/A

Critical Event #8



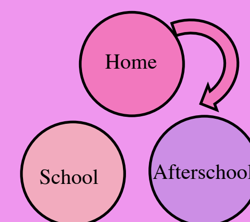
Event: Show and tell
Resource: Clay
Recognition: N/A
Identity Resource: N/A

Critical Event #9



Event: iPad research
Resource: Forrest and technology
Recognition: N/A
Identity Resource: N/A

Critical Event #10



Event: Pool noodle flowers
Resource: Arts and crafts
Recognition: Lulu
Identity Resource: N/A

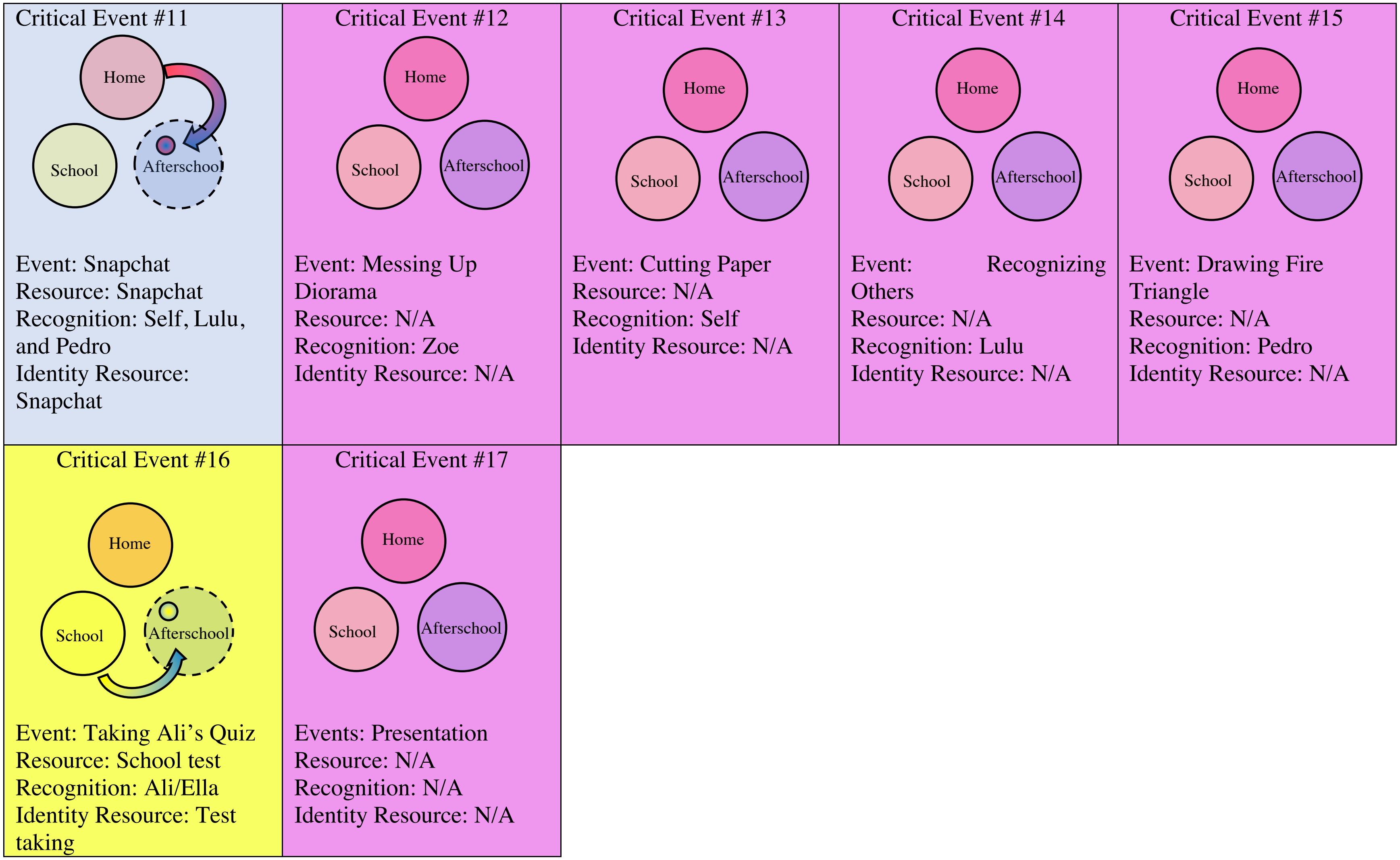


Figure 5.3. Ella's Generated Identity Resources
Note. More information about the Critical Event is found on Table 5.3.
Identity Heat Map: Green = sense of self in science, destabilization: Blue = toward sense of self in science, Yellow = destabilization: towards sense of self away from science, Red = sense of self not in science.

Table 5.3. Events for Ella (Starred Events are Critical Events [CE] Written in the Findings)

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #1 10.19	During the food activity, Lulu tells Ella, in Spanish how she is a spicy girl when looking up the types of foods Ella was interested in understanding	Home based resources of making salsa	Lulu makes a language connection with Ella to try and create a connection	Lulu recognizes Ella's interest in salsa and is connecting it to her language and culture	None	Lulu is recognizing the intellectual work and home cooking resources of Estrella	Intellectual work on the worksheets and the ideas from the cookie lab	Connections to science and home life	High sense of self with connections of home and science

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #2 *11.16	Ella is being cut off and interrupted by both Maz and Pedro. They say they have to reinterpret what she is saying so that the classroom can understand her. She is also told by Lulu in Spanish that she needs to pay attention.	Home based resources such as TV resources and how radio waves are a part of radio energy	Spanish is used to scold Lulu and to keep her on track of the task. Lulu asks her what is wrong.	Ella is recognized as someone who is not articulate in science. Ella is also recognized as someone who is not paying attention and not contributing to the group work.	Nobody mentioned the intellectual work that Ella took part in when presenting during the posters. In fact, many undermined her intellectual work as not capable enough.	Maz and Pedro are recognizing Ella as not capable enough to communicate the idea to the larger community. Lulu is recognizing Ella as being down and not contributing to the group poster presentations.	Poster that she was a part of	Destabilization of scientific intellectual work and performances	Destabilization; no intellectual contribution

Date	Description	Resources Leveraged How is Language used as a Resource	How is Langua ge used as a Resour ce	How Are Girls Recognize d and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognitio n work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #3 12.07	In the start of the event, Ella responds that she doesn't care about the direction of the project. She constantly says she doesn't care and when trying to explain the energy she sees; Caleb keeps cutting her off when she starts to explain what kind of energy she is going to focus on. During the script writing, Lulu says, in Spanish, Ella is the only one who is writing down answers.	Spanish based resources when talking praising Ella. Furthermo re, some of the home based experience s that radio waves are drawn on include watching TV.	Spanish is used as a way to praise student s	Ella is positioned by Caleb as someone who doesn't have much to contribute and is cut off. Lulu recognizes the contributi on in writing that Ella is participati ng in.	None	Caleb, her peer, is recognizin g her as someone who he can cut off and doesn't have a space to speak up. Lulu is also doing the recognitio n work of Ella and her script writing.	Script that Ella is workin g on	Decreased expertise in science and increased participati on in activities	Low sense of self' does not want to participate and is being cut off

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #4 01.18	Ella talks about the flip phones that she has seen. She talks about communicating using which phone and Tessa engages in a conversation with her.	Home resources such as chatting on the phone. Ella talks about texting.	None	None	Missed opportunities from Tessa to be recognized	Tessa	Worksheets	Learning more about communication and the affordances and constraints.	Low sense of self; minimal participation
CE #5 01.25	During the group discussion, Ella was asked about whether or not grass was living or nonliving.	Home based resources such as playing outside and playing soccer	None	Tessa told her good job		Tessa is recognizing her intellectual contribution to the discussion	Worksheets about the YouTube video	Learning more about the scientific idea of what is living or non-living	Low sense of self; minimal participation

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #6 02.01	Ella wants to do research with the iPads and tries to stay on task, but other students try to put her down.	None	None	Ella was recognized as someone who was not doing work and someone who doesn't care about contributing	Ella was not able an opportunity to be able to do the activity; in fact, she was constantly cut off by her peers.	Maz and the other students are recognizing Ella as not someone who contributes	Work sheets	Ella becomes less engaged in the intellectual work	Low sense of self; minimal participation and recognition as a non-science person
CE #7 *02.15	Ella is interrupted by Pedro during the group conversation, Ella also tries to blame Ali for being a problem in the group dynamics, Zoe says that Ella doesn't work hard, and she becomes off task and starts writing on the board.	None	None	Ella is constantly not given a space to express herself and is positioned as someone who does not contribute to the group.	None	Ella's peers are recognizing her	Drawing Hi on the white board	Ella is destabilized in not given a space to express her ideas and her contributions to learning science is seen as lesser than others.	Low sense of self; minimal participation and recognition as a non-science person

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #8 02.22	Ella brought a piece of clay. She shared with Zoe	Home based resources such as crafting	None	None	Ella was quiet during the presentation. She went up with Zoe and did not have much to say.	With the missed opportunity, Ella was positioned as passive	Clay ball	Positioned as passive and having difficulty articulating ideas about connections to science	Low sense of self; minimal participation and recognition as a non-science person
CE #9 *03.01	Pedro asks Ella if she is going to do anything useful. Ella starts researching on the iPad some of the information about forest fires. Lulu tells everyone to listen.	Home based resources with the iPad and community-based resources such as caring for the environment	None	Ella was first positioned as someone not doing anything useful, then Ella tries to restabilize herself and her participation, then Ella was positioned as an expert with valuable knowledge	None	Pedro, Lulu, and herself	Yosemite Wildfires news article on National Geographic's	Interest in science, expertise in science, and carving a voice for Ella to speak	Low sense of self; minimal participation and recognition as a non-science person

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #10 *03.08	Ella is told by Zoe that she isn't doing anything. Lulu says she can participate more. Ella says she doesn't understand. Ella reluctantly says she can make flowers from the pool noodles. Lulu has to have a conversation with Ella about her participation.	Home based crafting supplies that Ella wants to bring to school	Lulu uses Spanish when she is talking to Ella about her participation	Ella is first positioned as someone who isn't doing anything, when she starts to work on a project and starts making flowers, people still say that she isn't doing anything. Ella says she has a smart idea but Alondra tells her not to do it	Ella is not recognized for her contributions to the project which include making the flowers for the ecosystem diorama.	Her peers are positioning her as someone who is not engaged. Lulu also positions Ella as someone who needs to contribute. Lulu positions Ella as someone who is contributing but can do it in other ways. Lulu also finds ways for Ella to bring in her home supplies to work on the project	Pool noodle flowers	Less interest in science and the work, not feeling like Ella belongs into the group, but she tries to be able to participate by bringing in home supplies.	Low sense of self; minimal participation and recognition as a non-science person

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #11 03.15	Ella edits the ecosystem video with the fire emojis using Snapchat. She is also complimented on the pool noodles she is making. Zoe says Ella isn't doing anything, but Lulu said she is. Pedro says Ella is #winning	Home based resources of using Snapchat	Only inside conversations and phrases	Ella is recognized for her work using the Snapchat app to help edit the videos. Zoe positions Ella as not contributing but Pedro and Lulu validate Ella's contribution	None	Ella compliments her own work. Pedro and Lulu validate her work. Zoe says that she does not contribute to the group	Short clips that Ella edited on Snapchat	Participation in activities	Neutral, high participation and engagement in science

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #12 04.12	Ella did not have much of a role but she got paint on the diorama box. Zoe started to blame her messing up the project.	None	None	Ella was recognized as someone who messed up the project	None	Zoe	Stains on the diorama box	Decreased participation in activity	Low sense of self; minimal participation and recognition as a non-science person
CE #13 04.26	Ella grabs a pair of scissors and starts to cut the worksheet	None	None	Ella is positioning herself as someone who does not want to participate	None	Ella is recognizing herself in her lack of engagement	Worksheet that is cut up	Decrease participation in activities	Low sense of self; minimal participation and recognition as a non-science person

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognitio n work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #14 5.17	Ella sees upset because Lulu was recognizing Ali for doing the work	None	None	Ella seems to want the attention for Lulu and wants to go outside	Not recognized for her contributions to the project	Lulu is recognizin g other students	None	Changes in want to participate in the activity	Wants to participate and contribute to activities
CE #15 *05.24	Ella is trying to contribute to the mini lesson that Lulu is giving. Pedro is drawing the fire triangle on the board. Ella starts to draw on the board, but he erases her arrows.	None	None	Ella is positioned as not having any intellectual contribution to the group conversatio n	Missed opportunities to contribute to the intellectual work of the fire triangle	Pedro is doing the recognitio n work and erasing all of Ella's contributi ons	Erased fire triangle arrows on the white board	Decreased participation in activity and trying to note there is no entry way to participate for Ella	Low sense of self; minimal participati on and recognitio n as a non-science person

Date	Description	Resources Leveraged How is Language used as a Resource	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recogniti on work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #16 05.31	Ella takes Ali's test, but Ali said that she is going to get an F. Ella gives herself an A+. Ali gives Ella a 110%. Ella said she is going to make a test and it's going to be extra hard.	School based quiz taking resources	None	Ella is recognized as not intelligent, then positions self as someone smart, then a top student in science, and tries to show her knowledge	None	Ali is recognizing Ella as not smart and Ella is positioning herself as smart	Ella writes 110% on the quiz Ali gave her	Increased participation in science when positioned as not smart. Positions self as someone who wants to be smart	Destabilized; Want to engage but finds it difficult to be a part of the group

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition on work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #17 06.07	Ella is quiet throughout the observation	None	None	None	Missed opportunity for contributing to the team	Lulu mentioned that students had bright futures ahead	Medals	Ella is lost within the shadows of others	Low sense of self; minimal participation and recognition as a non-science person

For example, when Ella did not have a place to be able to participate in STEM, she made opportunities to draw and write on the white board (see Critical Event #7 and #15). If drawing on the white board had occurred in school science, Ella would not be following the rules and norms of creating opportunities to participate. After each instance of tagging and drawing on the whiteboard, Lulu found opportunities for Ella, such as searching for a related video and building the flowers from the pool noodles. Yet, those opportunities to engage came too late, as the after-school session was ending. There was minimal time and opportunity to celebrate and recognize Ella's participation and accomplishments in the activities.

In this counter-space, however, Ella had difficulty fully engaging in STEM activities. As stated before, there were many places where Ella started to lose momentum or was prevented from building momentum to participate in science. Ella's participation in the activities started off really strong. Yet, when she was interrupted, not only once but twice (see Critical Event #2), Ella became positioned as someone who did not have expertise in STEM. Again, in this counter-space, she was positioned as someone who did not work hard (see Critical Event #7).

In Critical Event # 15, students were working in groups to create a poster. They were using a skeleton outline to articulate their ideas and problem of their ecosystem. The students presented their poster to the entire class.

Vignette. To make part of the poster, Ella was given the worksheet with the guiding questions to help her group prepare. Ella asked a question about affected populations and described the affected population. Tessa asked who could answer that question and pointed to Ali even though here hand isn't raised. Pedro responded to the question, saying animals and plants. Ella stopped Pedro and said, "one thing, one thing." Ella pointed to Zoe. Pedro said "NO" and continued to talk and try to answer the question. Ella became visibly frustrated by all the information that Pedro was telling her at once and said, “just one thing!” Tessa interjected with “wait” and asked Ella to read the question. Ella went around and asked Pedro and Ali for responses. Then she asked Zoe for her response. Ella moved onto the next question, “what is the problem.” Ella kept the students accountable by making sure everyone was contributing and helping to answer the prompts. Zoe said humans are the problem. Ella responded to Zoe, saying “she’s the problem” and pointing to Ali. Ali said, “who me?” Ella said “no…” and looked away to whisper something to Zoe. Ella continued to read off the question and ask her teammates for support.

Most of the group members do not answer the question or provide round-about answers similar to the example provided above. After Ella attempted multiple times to organize the group in answering the questions, Ali, Pedro, and Zoe started working on the poster. Ella was not given a specific role for the poster and many times sat next to the poster but does not contribute. At one point, Ella started writing on the whiteboard: “hi.” Ella asked what she could do to contribute. Ignored, Ella grabbed a marker from the white board again. She drew on the whiteboard again: “Hiii.” Tessa told Ella to ask her group how she could contribute to the poster. Ella copied Tessa’s language, “Zoe, how can I contribute to the poster?” Ignored again, Ella drew an arrow on her drawings on the whiteboard. Tessa told her to work on the poster. Tessa asked Ella to move to the poster and contribute. Tessa asked if Ella wanted to draw and asked her to contribute one thing to the poster.

Alondra made an announcement to the group about wrapping up. Zoe told Pedro not to use the bottom of the poster. Tessa said that the group can write notes and then use the back. Ella announced that she was done with the job. Zoe said, “Ella doesn’t work hard like us and it isn't fair." Ali said, "she doesn't work hard and should be on her side." Referring to where Ella was sitting.

Identity Work. In this Critical Event, Ella first deeply engaged in the activity. She attempted to keep her group accountable for their intellectual work and ensured that everyone had a role. Yet, her groups mates were either overwhelming her, such as when Pedro spoke faster than Ella could write or denying her a specific role in the poster activity. Without her role, she walked off to the white board and engaged in another activity: tagging the white board. It would be unfair to blame Ella for not contributing to the activity and the poster. Ella even asked her peers how to contribute. Zoe did not have a role for her and thus Ella continued to engage in tagging and drawing on the white board. In the end, because Ella did not have a role, Zoe positioned Ella as not being helpful. By doing so, Zoe did not recognize the intellectual work that Ella contributed when working on the guiding questions and gathering her teammates' responses. This Critical Event further recognizes the moments in which when Ella did not have a role, in which she was writing and drawing on the white board. Furthermore, this positioned Ella as someone who was not contributing to the activity and someone who took advantage of her group, as Zoe said, "it's unfair." With Ella, her previous contributions were not recognized, and were delegitimized by Zoe. What ended up being recognized were those moments in which Ella was *not* contributing because she lacked a specific role in the activity. Her efforts to contribute and engage in STEM learning activities were overlooked when her non-contribution was recognized. Here, we see a loss of momentum for Ella, further developing her identity as a non-science person.

Bilingual Resources. It is important to recognize how Spanish was used to support Ella in her engagement in science. Though Ella never directly engaged in Spanish in the observation, Lulu used Spanish as a way to reengage Ella in the STEM activities. For example, Lulu engaged in Spanish when talking to Ella about pretend play and buying tacos (see Critical Event #9). In this Critical Event, Spanish was not used directly to participate and engage in the STEM activities but as a way of bonding and building relationships (*convivir*) with Ella. Through this pretend conversation of ordering tacos, Lulu continued to pretend that the taco shop was closed, and that Ella's attention would need to be diverted to engaging in the activity. Furthermore, Lulu used Spanish to attempt to engage Ella in the activity by apologizing to her (see Critical Event #10) for making her feel like she is not part of the group. For Ella, these Spanish-language resources were the precursor to engagement in the STEM activities. After Lulu connected with Ella on a personal level about her participation, Ella started to engage.

In Critical Event #9, Lulu and Ella were conversing about tacos while playing with Lulu's phone. As part of the winter quarter project, students were working on a video documentary of their local ecosystem. During this activity, Ella and her group conducted background research on the ecosystem they selected (the forest).

Vignette. Lulu sat with the group and Ella asked Lulu for her phone. Ella pretended to call Lulu and order tacos in a pretend phone conversation. Lulu responded with "*mañana, ahorita estoy cerrada* [Tomorrow, my business is closed right now]" trying to redirect Ella to reengage in the activity with the group. Zoe said, "tomorrow" referring to ordering tacos. Ella asked, "what days are you open?" "On the weekends, when you don't have school" Lulu said trying to redirect and reengage Ella in the activity and script writing. Ella, still holding Lulu's phone, said that she is going to order more tacos. Lulu said, "*Ya no tengo tacos hoy, se me terminaron el [sic] carne* [no more tacos for today, she doesn't have meat]. *Ya no tengo nada, perdon, hasta mañana*" [Until tomorrow, sorry]." Lulu tried again to redirect Ella playfully into participating and engaging with the activity of conducting background research on forest fires. Lulu then asked for her phone back. Ella was resistant and asked Lulu if she could order more tacos. Lulu obliged and continued in the pretend conversation, with Ella ordering tacos. "What kind?" Lulu playfully responded. "Chicken!" Ella responded. "*Uno taco* [one taco]," Lulu confirmed the "order." Lulu then asked for her phone back to try and reengage Ella in the activity. "Next week," Lulu told Ella.

After the conversation about pretending to order tacos, Lulu attempted to reengage Ella in the activity by reminding her of the task at hand. Lulu reminded the students that "it is important to have fun, but they need to have fun while working. It is important to have fun but not to neglect the work." Lulu walked around the table where her group was located, checking in each of the students. Lulu announced out loud, "*Porque ahorita nada más veo dos* (right now, I only see two)." Lulu made it very clear that she only saw Pedro and Ali working on the project. Pedro reiterated what Lulu said and to his group, in particular Zoe and Ella, "you're not helping though."

Lulu again attempted many times to try and keep Zoe and Ella accountable for the work. Lulu reminded Zoe and Ella that they "need to focus." Lulu even asked the other participating members, Pedro and Ali, how they felt their teamwork was going. Pedro stated that "he feels like they could be doing a bit more." Ali said that she "feels disappointed."

After multiple attempts to engage Ella and Zoe, Ella eventually started to conduct an internet search researching the impact of forest fires. Ella eventually found a video about the Napa Fires and statistics about forest fires. Ella showed Lulu the video. Lulu immediately asked the other students to take notes on the video that Ella found. Lulu told the group, "*¿estamos* *poniendo atención a Ella?* [are you paying attention to Ella?]" Lulu further positioned Ella as an expert by announcing to the group that, "Ella found a useful video."

Identity Work. In this Critical Event, Ella began with being off-task and talking about tacos. Lulu entertained this idea to try and reengage Ella. As she continuously engaged in pretend play about tacos. Lulu tried to keep Ella accountable and reengage. Lulu positioned and recognized Ella for *not* participating by mentioning that she saw that Ella was not helping much. Lulu even asked Ali and Pedro for their perception of Ella's participation. Ali and Pedro positioned Ella as someone who could do more. In these interactions, Ella was positioned as someone who did not contribute and did not have a role in the activity. In fact, Ella found way to participate in non-STEM related activities such as playfully pretending to call Lulu for tacos.

Yet, toward the end of being positioned as someone who did not engage, Ella found a way to excel and participate. She created a role for herself to look up information and contribute to the group. Furthermore, Ella was recognized by Lulu for contributing to the conversation and the overall activity. Lulu asked the other students to make notes from the video that Ella found. Overall, the identity work of Ella in this Critical Event wavered. Only toward the end did she engage and become recognized for her STEM engagement and her participation. However, for most of the activity, Ella was not participating and furthermore was recognized as someone who did not participate or contribute to the group. She was positioned as someone who constantly needed to reengage with the classroom and her peers and was positioned as someone who did not help much.

Ella's language use with Lulu demonstrated an instance where bilingualism was leveraged to build community in the classroom. Lulu used her bilingualism to build community within the classroom and with Ella in particular (Creese & Blackledge, 2010; Palmer, Mateus, Martínez, & Henderson, 2014; Sayer, 2013). Ella also switched between non-science social talk and academic talk, representing a switch in registers (Daiute, 2005; Reyes, 2004). Many of the other types of registers and talk that Ella used and engaged with included casual social talk, storytelling, and telling jokes (Ballenger, 1997; Halmari & Smith, 1994). In doing so, this social talk accessed opportunities for Lulu and Ella to bond which helped develop a rapport (Ryu, 2019). The after-school space as a counter-space, challenged norms and traditional rules of what counts as engaging and learning. Though there was still an academic task at hand, the expectations, norms, and consequences are not the same as in school settings (e.g. academic performance and grades). The counter-space of the after-school program rejected the hierarchical structures, norms, and expectations present in traditional learning (Gutiérrez et al., 1995; Hirst & Renshaw, 2004). The after-school counter-space became a space where all participants were able to make jokes, bond, and freely use the language of both academic and casual social linguistic resources.

Case 4: Zoe - The Case of the Risen

"Just like moons and like suns,

With the certainty of tides,

Just like hopes springing high,

Still I'll rise."

– Maya Angelou, Still I Rise

Zoe was a 5th-grade girl who identified ethnically as Latina. Her mother, who worked as an admission counselor at a local community college, raised Zoe, her high-school age sister, and her brother, who worked as a police officer. Zoe's father had, at the time, been incarcerated for a long term. Many of the teachers said that Zoe did not talk much about her father at all. When asked about her family, Zoe would mention her father, then retract that information and pretend that she had not mentioned her father at all. Zoe was also very active in *folklorico*, often participating in the after-school program as well as dance instruction on the weekends. Zoe turned to her older sister often for academic support. For example, Zoe's older sister would conduct science experiments with her and make homemade ice cream in the summer.

After-School Experiences. Zoe's engagement in the after-school program was extremely positive. She stated that one of the most memorable activities they completed was an energy unit on the radioactive lemon. During after-school activities, Zoe remained close to Ella. It was noted by the researchers that it seemed that Zoe had an extremely dominant personality, excluding and including Ella according to her whims, while Ella was quite shy. Overall, her participation was extremely high, moving from someone who was afraid of public speaking and classroom presentations to someone who was more comfortable with presenting at the end of the school year.

School Experiences. In terms of her school participation, the teachers labelled her as a top student. Based on interviews with Zoe, one of her favorite science activities was an experiment about cooking in school. She enjoyed it because she loved to cook and loved food. However, in the school setting, science was not generally as interesting because she was learning about things she already knew or understood well.

Positioning Self. Zoe's survey indicated a high interest in science, high science achievement (i.e., grades), high interest in science-related careers, but few science-related after-school activities. At her end of the year survey, her responses had not changed, except that Zoe indicated participation in after-school science activities. Zoe stated that she was never a high achiever in science until the 2nd grade.

Positioned by Teachers. Zoe's teachers stated that she could be a scientist and a strong science student. Outside of her academics, her teachers stated that Zoe had a bubbly personality and was often really loud, which could be distracting. They credited her strong work ethic to her family's perseverance.

Summary of Zoe – The Case of the Risen

The Case of Zoe across her Identity Heat Maps (see Figure 4.1) showed a high sense of self in science overall, risen from someone who had not originally engaged much in STEM. Over time, Zoe was recognized by her teachers as a science person and she recognized *herself* as someone who could do science. From the Critical Events, three consistent patterns arose: use of counter-spaces to engage in activities and use of language resources to support her engagement.

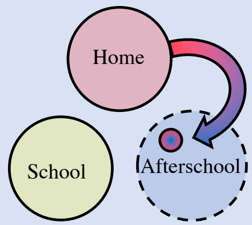
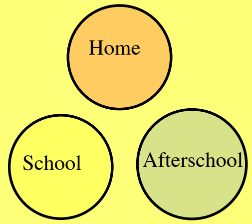
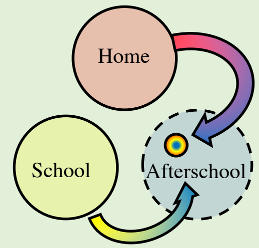
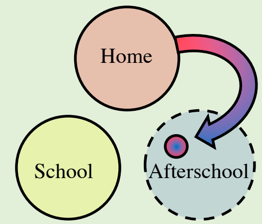
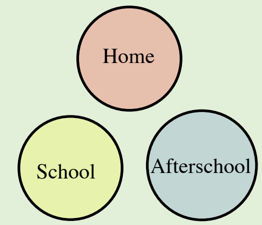
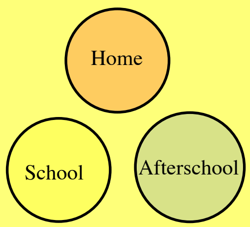
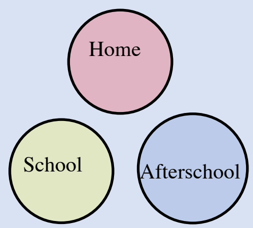
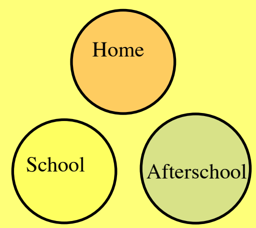
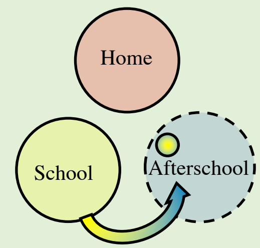
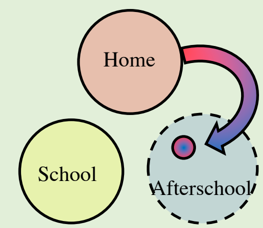
Zoe's case was the "Case of the Risen" because of her quick growth and change in participation in the after-school STEM program. There are moments in which she started off low in her engagement but quickly increased participation, even in the course of a single observation. In other words, Zoe's engagement rose quite quickly. The thirteen events of Zoe (see Table 5.4) showed varying connections of home- and school-based practices in the after-school activities as well as moments in which she recognized her own expertise in science and moments in which her science expertise was recognized by others.

To better understand how Zoe's generated identity resources, I combined the conceptual framework of identity resources (Figure 3.1), the Identity Heat Map (Figure 4.1), and the Critical Events table (Table 5.4). Creating Zoe's Generated Identity Resources (Figure 5.4) helped us understand how resources were leveraged and recognized, how identity resources were generated, and how generating identity resources related to Zoe's STEM engagement.

Counter-Spaces. In terms of developing a counter-space, Zoe was able to participate in the after-school program by creating a space in which she could succeed and self-recognize her accomplishments and expertise. This challenged many power dynamics of the students as the learner, as Zoe took ownership of her learning. By self-recognizing her accomplishments and expertise, Zoe relied on herself to be successful rather than on traditional norms of achievement, such as tests and grades.

For example, when watching the video on YouTube, Zoe self-recognized herself for "having a good answer" (Critical Event #3). In this case, Zoe gained self-recognition for having expert knowledge and participating in the activity. This was also shown again when Zoe said that Ella "does not work hard like us and it isn't fair." In this instance, Zoe was stating her values and expectations that others would work hard like herself. Finally, this self-recognition was also clear when Zoe positioned the research assistant Sophia as someone who would ruin the timer and put the batter upside down (Critical Event #11). Again, in this instance, Zoe was an expert compared to others. It was through this self-recognition that the afterschool became a counterspace for Zoe. She was able to showcase who she wanted to be and how she felt accomplished outside of the traditional ways of being successful in school such as grades.

Vignette. In Critical Event #3, Tessa, Alondra, and Lulu led the class in discussions about the ecosystems students interact with, the living or nonliving aspects they see in them, and the possible issues that arise in these ecosystems. The students watched a video on YouTube of forest creatures and had to identify the various non-living and living things on a worksheet. This was a transitional activity rooted in very typical school-based norms and rules. The UCI

Critical Event #1  Event: Recipe Activity Resource: Foods from home Recognition: Self Identity Resource: Recipes and cooking from	Critical Event #2  Event: Disinterested Resource: N/A Recognition: N/A Identity Resource: N/A	Critical Event #3  Event: Forrest Ecosystem Resource: School and home about nature Recognition: Self Identity Resource:	Critical Event #4  Event: Forrest ecosystem Resource: Community and being responsible Recognition: Zoe recognizes self Identity Resource: Caring about the community	Critical Event #5  Event: “Doesn’t work the same as others” Resource: N/A Recognition: Self Identity Resource: N/A
Critical Event #6  Event: Show and tell Resource: N/A Recognition: Didn’t want to be recognized as someone who was forgetful Identity Resource: N/A	Critical Event #7  Event: Confused about project Resource: N/A Recognition: Recognized as someone who could be doing more Identity Resource: N/A	Critical Event #8  Event: Watching Forrest Video Resource: N/A Recognition: Recognized as non-expert Identity Resource: N/A	Critical Event #9  Event: Viewing party Resource: School worksheets Recognition: Lulu Identity Resource: School norms and worksheets	Critical Event #10  Event: Don’t Stress Resource: Spanish Recognition: Lulu Identity Resource: Spanish proverb (*dichos*) of don’t stress

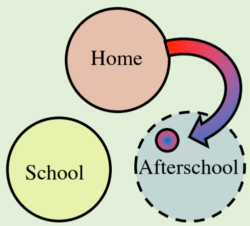
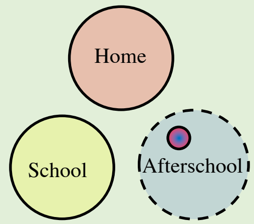
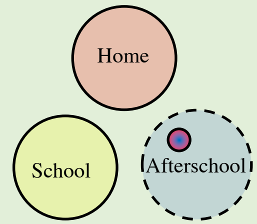
Critical Event #11	Critical Event #12	Critical Event #13
		
Event: Building self-extinguishing fire pit Resource: Tools Recognition: Lulu recognizing Identity Resource: Home tool usage	Event: Fire Triangle poster Resource: N/A Recognition: Self recognition Identity Resource: Previous work	Event: Presenting Poster Resource: N/A Recognition: Recognized projects are good Identity Resource: Previous work

Figure 5.4. Zoe's Generated Identity Resources
Note. More information about the Critical Event is found on Table 5.4.
Participation Heat Map: Green = Engagement, Blue = Starting to Engage, Yellow = Starting to Not Engage, & Red = No Engagement

Table 5.4. Events for Zoe (Starred Events are Critical Events [CE] Written in the Findings)

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #1 10.19	During the recipe activities, Zoe wanted to keep the recipe guides of the cookie lab. During the time she was going through the cookie ingredients, Zoe was making a list of ingredients in her hand and she keeps mentioning sugar and cinnamon over and over again.	Home based resources about cooking and the types of foods they eat	None	None	Recognizing the intellectual work of herself and wanting to be able to continue on with doing more of the activities at home	Self	Wantin g to take back the recipe cards from home to try and make cookies	Interest in science starting to develop and connection to home based cooking practices	Interests in science connectin g to home and cooking life

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #2 11.09	Throughout the whole lesson, Zoe states she is tired and is not contributing much to the conversation. She seems out of touch and is disinterested.	None	None	None	Not recognized at all	None	None	Disinterest in Science	Instability; low interests in science
CE #3 *01.25	Pedro and Zoe have conversations and back and forth. Pedro tries to tell Zoe she is wrong and corrects her. Zoe also seeks Pedro's approval when she gets an answer correctly. Zoe then also tries to correct Pedro when he had something incorrect.	School based resources on learning about ecosystems. Also, nature based resources because Zoe likes to be outside in the forest.	None	First Zoe was positioned as incorrect, then Zoe positions herself as someone who does a good job, and finally Zoe tries to position herself as correct by correcting Pedro	None	Mostly Zoe recognizes herself to try and stabilize her work, but she looks for Pedro's approval for the recognition.	Work sheets	Positioned as an expert in science	High sense of self; able to become an expert

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #4 02.01	When discussing the ecosystems of the forest, Zoe tells her group that technically humans cause the forest fires. When Morgan makes fun of homeless people, Zoe tells him it's not funny.	Feelings about the community and being responsible	None	Zoe recognizes herself as someone who has expertise	None	Zoe is recognizing herself as an expert by inserting her ideas and being assertive in the conversation.	Worksheets with the guiding questions	Zoe started to establish expertise of the ecosystems	High sense of self; able to become an expert
CE #5 *02.15	Zoe says that Ella doesn't work the same amount as her and the other people. Zoe is also quick to respond to the questions that Ella asks.	None	None	Zoe is positioning herself and recognizing the work that she has contributed to the project	None	Self	Poster	Engagement in science	High sense of self; high engagement in science

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #6 02.22	Zoe forgot her Science artifact and kept asking Ella to borrow and share with her.	None	None	Zoe wanted to position herself as someone who was not forgetful and was on task	None	None	Clay ball from Ella	Felt like she was scramblin g to get by; being a good student identity	Destabi lized; sense of self sort of dipped
CE #7 03.01	Zoe is confused about the goals of the project and she is vying for Lulu's attention	None	None	Pedro says that he feels that Zoe could be doing a little bit more. Zoe also positions herself in the backseat letting her group plan everything out for her.	Not recognized as someone who has a role and can jump back into the group	Peers are recognizing Zoe as could be doing more. Zoe also positions self as not doing a lot.	Worksh eets	Zoe has less contributi on for the project	Restabi lized sense of self; particip ation wavere d but increas ed

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognitio n work	Identity Artifact s	Outcome	Sense of Self and Shifts in Identity
CE #8 03.15	Zoe has a debate with Pedro about what animals should belong in the forest ecosystem diorama that the group is making. Pedro argues against her and saying that her choice of animals is incorrect.	None	None	Recognized as someone who has limited knowledge and understanding of science and the forest ecosystem.	None	Pedro is recognizin g Zoe as a non-expert and Zoe is positionin g herself as an expert.	Animal toys for the dioram a	Zoe's contributi on is attempted to be destabiliz ed but she continues to try and negate the comment	Destabil ized; sense of self dips and becomes lower
CE #9 04.26	During the viewing party, Zoe rolls up the paper. Lulu says they are going to have to turn it in and think of it as classwork.	School based resources	None	Recognized as a student that needs to keep her intellectual work accountable even in after-school settings	None	Lulu is recognizin g the work that Zoe is doing that is still connected to school norms	Rolled up worksh eet	Legitimiz ation of her intellectu al work that is similar to school	High sense of self; legitimiz ation and participa tion of science activity

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifacts	Outcome	Sense of Self and Shifts in Identity
CE #10 *05.17	Zoe is stressed out about the work when trying to find and look up information on the computer.	None	Lulu tells Zoe not to stress in Spanish	Recognized as being stressed	None	Lulu is recognizing the tension that Zoe is experiencing	Worksheet on the computer	Increased participation in the activity.	High sense of self; legitimization and participation of science activity
CE #11 *05.24	During Lulu's lesson, Zoe tries to prevent Maz from participating. Zoe is working hard on taking apart the timer. Sophia comes over and grabs the battery. Lulu also tells Zoe that she is proud of the group.	Home based resources playing with the tools	None	Recognized as being accomplished in the activity, wanting to be a learner, and being an expert in the timer	None	Lulu is recognizing Zoe for her contribution to the group. Zoe is also recognizing herself for being an expert on the timer	Timer that Zoe is drilling and taking apart	Increased participation, ownership of the science artifacts, and expertise	High sense of self; legitimization and participation of science activity

Date	Description	Resources Leveraged	How is Language used as a Resource	How Are Girls Recognized and Positioned	How are Girls NOT Recognized (Missed opportunities)	Who is doing recognition work	Identity Artifact	Outcome	Sense of Self and Shifts in Identity
CE #12 05.31	During the group lecture that Lulu has about the fire triangle, Zoe says that she pays attention. Zoe also asks what the purpose of their project is	None	None	Zoe takes ownership of her work and says where her box is. She is also positioned as an expert and highly engaged in the activity and intellectually contributing	None	Zoe is recognizing herself in ownership of her work, Lulu positions the students as experts, and she recognizes Zoe for her intellectual contribution	Box timer that Zoe is working on and the fire triangle drawing that Lulu draws on the board.	Ownership of contribution and increased participation and increased expertise	High sense of self; legitimization and participation of science activity
CE #13 06.07	Zoe says she does not want to present but that she is done with her poster.	None	None	Zoe is told that her projects are good	None	Kasim says that they did good projects.	Medal and poster she made	Science expertise and science contributions to their teams.	High sense of self; legitimization and participation of science activity

educators discovered from the previous week that the pace of the after-school curriculum was not aligned with the school science curriculum. In other words, the students were barely were introduced to the ecosystem unit at the time that this topic was being covered in the after-school program. As a result, a video was played to align with the school curriculum per CBA's request, since the insight of the misalignment occurred the day before.

Before watching the video, Alondra, Pedro, Ali, Zoe, and Ella sat together to discuss the definition of the key terms. Alondra asked what the students think "living" is. Pedro answered that it means that they live and breathe. Zoe commented, "Plants don't breathe!" Pedro responded that "they don't breathe, but they go through photosynthesis" disregarding Zoe's comments. Moving the conversation forward, Alondra asked, "what is photosynthesis?", and Pedro explained. Alondra said that living things consume things.

Alondra then asked what else living things do. Pedro answered, "reproduce." Zoe agreed that plants reproduce. Alondra asked Zoe and Pedro for examples of living things - things that reproduce, consume, and breathe. Pedro answered, "a tree and a frog." Alondra, Zoe, and Pedro moved on to "non-living" things. Zoe provided rocks and sand as examples. Pedro pointed out that they do not consume, but dirt absorbs water. Alondra asked, "if the dirt consumes on purpose or not." Pedro said that "it isn't on purpose, just like humans don't breathe on purpose." Pedro and Zoe discussed examples of decomposers. Pedro answered fungi, and Alondra told him "Good job." He provided mushrooms as an example of fungi, and the three of them discussed mushroom size. Pedro told them that there are some mushrooms that release gas when irritated. Zoe joked, "And then you get poisoned and then you die! Just kidding." Pedro responded "no, it's just gas." Zoe joked, "They have a lot of gas...I wonder what they ate."

Tessa then grabbed the class's attention to share the definitions of the terms as well as any examples the students came up with. For non-living things, Zoe answered that they do not reproduce. Tessa said, "Good." Zoe turned to Pedro excitedly after she answered, "I got a good answer." Zoe gave her a thumbs up and said, "Yas!" Zoe then said, "We got it good" and pointed between herself and Pedro.

Identity Work. In this Critical Event, Zoe leveraged her cultural resources from being successful and "perfection" (according to her teachers) to participate and position herself as an expert in STEM. Zoe engaged with the traditional school norms and practices that were part of this activity. Zoe tried to be funny and talked about the mushrooms releasing gas as a joke. Pedro, who recognized this as factually incorrect, positioned Zoe as a non-expert in STEM. In order to continue to gain momentum, Zoe found ways to publicly be recognized as a STEM expert. Once she participated in the large group discussion, she not only self-recognized herself for a good answer but also turned to others, such as Pedro, in order to be further recognized for her STEM accomplishments. It is worth noting that this activity had school-like norms, rules, and expectations: raising hands, answering factual questions, watching videos, and completing worksheets. Because Zoe already did so well in the school setting, she was able to still participate.

Language. Spanish was used as a cultural resource to support Zoe's identity work. For example, Lulu was able to use Spanish to support Zoe's participation through the use of *dichos* (Critical Event #10) and through showing rules and norms for the activity (Critical Event #11). In Critical Event #10, Lulu was able to help Zoe calm down and participate by taking a moment to breathe and destress. Within this Critical Event, Lulu was able to support Zoe's engagement by relaxing the norms of the after-school setting. Lulu reminded Zoe that the after-school program differed from school in that there are no “correct” answers in the counter-space. Second, even though this program was a counter-space, there were expected rules and norms to follow for safety (Critical Event #11). By setting boundaries for Zoe, Lulu ensured that Zoe was still accountable for her learning in the after-school program, even if it did not look like school-based learning.

Vignette. In Critical Event #11, students built prototypes of a self-extinguishing fire pit. Furthermore, students prototyped different hinges to see which would best extinguish the fire. Zoe had the idea to create a self-extinguishing fire pit that would close on itself and built a prototype using hinges and a wooden box. During this time, Pedro drew the fire triangle, a model for understanding the necessary conditions to start a fire, on the white board (one of the sides of the triangles is oxygen).

As part of building their self-extinguishing fire pit, students used a power drill with drill bits to screw and unscrew hinges. Zoe had spent a lot of time working with the power drill. She unscrewed the different parts of the timer she was testing out. She also screwed the timer together after taking it apart. Zoe started using the drill to take apart the timer that they would be using as well as screw on hinges onto the box. Lulu came back and said, “I’m so proud of you guys!”

Sophia and Zoe were working on the clock taking it apart. Sophia watched and tried to help. Zoe said she was afraid that she was going to put the battery upside down. Sophia grabbed it and put it back, but Zoe started exclaiming “Don’t! Sophia!!” as if Sophia had done something incorrectly. Zoe said that Sophia messed it up. Lulu said that maybe she just wanted to see what she was doing and asked that Zoe let Sophia watch. “But she….” Zoe said.

Toward the end of the activity, students were completing their tasks. However, Zoe was distracted, and she started to walk around with the drill in her hand. Zoe took the drill, without the drill bit, and started to drill her hand. The drill was massaging her hand and Zoe exclaimed, "it feels so good!" Zoe also tried to use the drill as a massager on other students' hands. Maz, another case-study girl peered over while using the soldering iron, "You never know. *Si te cortas* [if you cut yourself]." Lulu turned around and approached Zoe, looking panicked. Lulu exclaimed, "*y sit e cortas, la responsabilidad no es con ustedes pero con nosotros* [and if you cut yourself, the responsibility isn't with you all but with us]." Lulu then asked the students in her group to clean up.

Identity Work. In this Critical Event, Zoe leveraged her tool use and aspects that make science interesting and exciting to support her own engagement with the activity. Zoe's first interaction with the drill was recognized by Lulu when she stated she was proud of them. As Zoe continued to build and create new tools with the power drill, Sophia offered to help. Zoe established her own expertise in building and creating. This in particular showed when Zoe acknowledged that Sophia was doing something incorrectly (e.g., putting the battery in the wrong way). Zoe's identity work continued to gain momentum quickly. As her engagement in STEM shifted, Zoe was able to not only be recognized by other people for her STEM engagement but was also able to self-recognize herself and her STEM expertise.

Dichos is a linguistic resource in language use that increases student's participation and engagement and encourages students to complete their work. *Dichos* is identified in the growing literature points as a resource to validate bilingual and non-dominant students in their learning endeavors. Previous literature has involved citing proverbs to maintain team spirit and encourage students to be on task (Anderson, Kagwesage, & Rusanganwa, 2013). Lulu, in both instances, was encouraging students while maintaining momentum and team spirit. Furthermore, in the counter-space of the after-school program, bilingualism was normalized and when Lulu uses *dichos* and engaged in a social action within the specific local context of the classroom (Palmer & Martínez, 2013). The leveraging of *dichos* became a meaningful and personal space of language use, particularly for Mexican-American students (González, Andrade, Civil, & Moll, 2001; López, Ynostroza, Fránquiz, & Curiel, 2015). For Lulu, who explicitly expressed commitment to the social justice of teaching and learning, these *dichos* are core reminders of resilience, empowerment, and motivation to continue to strive in *educación* as both a moral and community value.

Cross Case Analysis

Pattern #1: Having a Productive Role - Opportunities to Engage Deeply in STEM

The first pattern emerging from a cross-case analysis is that students need a specified role in order to have opportunities to leverage resources and engage deeply in science. In other words, when students do not have a role in the activity, they lose out on an opportunity to leverage their cultural resources and practice engaging in meaning making. I assert this claim based on the patterns I observed in the case-study girls, in particular Ali and Ella. I draw on the first notion of my conceptual framework, *leveraging resources* (Gonsalves et al., 2013; Tan & Calabrese Barton, 2008; Thompson, 2014), to explain the nuances of how cultural resources and practices are leveraged when these girls take up roles. In particular, I draw on how cultural resources are fluid and constantly negotiated in activities (Sewell, 1999). I look to how Ali and Ella reproduced their cultural practices in the after-school spaces within the roles they took up. In this section, I refer to vignettes to describe of how each case study girl's engagement in STEM changed when they took up certain roles in STEM learning activities.

Ella's Unproductive Role – Missed Opportunities to Leverage Resources. With Ella, most of the roles that she had in the activity either did not exist or came too late. Therefore, an opportunity to leverage these resources was minimized and difficult. For example, Ella did not have a role given to her when her group drew their poster on the fire triangle for their self-extinguishing fire pit (see Critical Event #15 on 5/24 on Table 5.3). Ali drew the poster, Pedro researched the fire triangle, and Maz built the prototype. Because of this, Ella started to draw on the whiteboard. Initially, Ella had asked for a role and a way to participate, but many ignored her. The only other way for her to participate was drawing on the white board and playing with different, unrelated materials. Still, Ella attempted to carve out a role for herself and to participate in any capacity she could. Without a specific role tied to the self-extinguishing fire pit project, Ella missed opportunities to showcase and highlight her cultural resources and practices, including what she knew and what she knows (Schademan, 2010). As a result, the opportunity to make connections meaningfully between her practices and STEM were severed (Calabrese Barton et al., 2008). When Ella did have a role, it was "too little, too late" in the learning activity.

When Ella found a role, she started to gain momentum in leveraging her resources and practices into the after-school space. For example, when finding the Yosemite Fires newspaper, Ella started to conduct research about the fires and look up information (see Critical Event #9 on 3/01 on Table 5.3). In doing so, she leveraged her resources of caring about the environment which she developed when camping with her family (Carlone & Johnson, 2012; Kane, 2011, 2016). Ella had a role: to search up background information that could be leveraged for her group and to a contribute to understanding the ecological problem that her group was focusing on. Yet this role came too late. Ella had only started to find articles about the Yosemite wildfires approximately ten minutes before the after-school session ended. During the next after-school activity, the Yosemite wildfire videos and news articles were not spoken of again. It was as if Ella's contributions and her role had made minimal impact to the group. During the next observation, Ella continued without a role in the project.

Ali's Productive Roles – Finding Opportunities to Leverage Resources. Ali initially shared many of Ella's same experiences of not having an opportunity to participate in the activity. For example, when Ali tried to showcase her home-based practices of making videos, many of her group mates did not this (see Critical Event #8 on 2/01 on Table 5.2). If Ali had taken on this role successfully, she could have leveraged and become recognized for her technology-based home practices (Chan et al., 2015). This would have generated opportunities for her to engage in science. However, Ali was not able to take up the role as the video creator. In fact, many of her groupmates barred her from taking on that role and even positioned her as a troublemaker. However, Ali needed to be creative and find other ways to participate in order to showcase her expertise and to take up a role showcasing her resources from home (Schademan, 2010). In order to carve out new roles for herself in order to leverage her resources.

In the many other instances when Ali was barred from taking on a role, Ali was able to carve out her own role to fashion new possibilities and opportunities to leverage her resources. For example, in the self-extinguishing fire pit project, Ali was rejected constantly for her ideas, including volunteering to draw on the poster (see Critical Event #15 on 5/17 on Table 5.2). If Ali had been given the opportunity to draw on the poster, she would have been able to leverage her home-based practices of drawing and art. Therefore, Ali had to take up a different role in order to participate. As a result, Ali took on the role as keeping her teammates accountable for the science idea and designs of the self-extinguishing fire pit.

In the Critical Events that followed, Ali took on an accountability role and created worksheets and quizzes for her groupmates (see Critical Event #16 & #17 on 5/24 & 5/31 on Table 5.2). Ali was able to leverage many of her school-based resources, such as typical school practices, to showcase her expertise and content knowledge. This is a resource that is valued in school-based science learning settings (Gutiérrez et al., 2011). Yet, in doing so, Ali exerted her agency in taking ownership of traditional school resources and rejecting the hierarchical roles and structures (Hirst & Renshaw, 2004). Instead of being graded by teachers and other adults, Ali reversed the power relationship in by becoming the actor holding *others* accountable for their science knowledge. The worksheets and quiz became an alternative way for Ali to challenge the power dynamics in the group. By doing so, Ali was able to participate and have a role, one that was non-mainstream and not often seen in group work: that of the challenger.

Pattern #2: Relative Recognition Work - Everyone is a Hero in their Own Story

With the cross-case analysis, the second pattern which emerges is that recognition work is relative. In fact, someone's recognition and expertise may occur at the cost of destabilizing others during their own identity work. The literature on recognition work shows that the relativity of the process creates meaning to those who participate (Davis & Singh, 2015; Zimmerman, 2012). Much of the literature shows that a dichotomy exists when girls, particularly of color, are recognized for their STEM accomplishments and are positioned as STEM experts during identity work (Calabrese Barton et al., 2013). The constant negotiations that a girl may conduct during identity work within STEM is in the context of other participants, positions, and structures surrounding the event (Holland et al., 1998). In drawing on social practice theory, the notion of figured worlds helps us to understand the setting of the after-school STEM program at CBA. A figured world is a "socially and culturally constructed realm of interpretations in which particulare characters and actors are recognized, signficance is assigned to certain acts and particular outcomes are valued over others" (Holland et al., 1998, p. 52). In this discussion, I emphasize that identity work occurs in the figured world of the after-school STEM program and includes not just the focal girl in thecase study but the other actors who may be impacted by her identity work.

I identified these patterns based on what I saw in the data when a student would present and reinterpret science ideas for others. One student might self-recognize themselves as an expert by delegitimizing another student in their science expertise. Below I refer to two vignettes from the case study girls. I then interpret the vignettes and the identity and recognition work that occurs from two different perspectives.

Vignette 1: For example, on November 2016, during the large group presentation, Maz showed her expertise to the large group by helping Ella describe the speed of light. Maz, Ella, and Pedro presented their PowerPoint on energy. Maz started off introducing what radio waves are: "Radio waves are part of the electromagnet waves of frequency. Radio waves exist across the electromagnetic spectrum. As you can see right here, it goes from 10.3… what is that?" Maz asked Lulu. Lulu said "Hertz." "It's a frequency and it goes from here to there," Maz said as she pointed to an image on the PowerPoint. Ella and Pedro then present and Maz continues on to presents examples of where they find energy waves. Some of the examples "includes radios, televisions, and cellphones. There is a picture of a cell phone" Maz said as she pointed to the PowerPoint. Ella then talked about "how it (radio waves) goes from one place to another. Radio waves travel very very very very quickly. They travel as fast as the speed of light. One fact, at the speed of light, the beam of light can go around the Earth at the earthquake more than 7 times per second" Maz then cuts in and said "what she means to say is that the speed of light. You can instantly hear radio waves. Your turn on and turn off the light. You can instantly see it when you turn on the light." The group finished presenting and the class clapped.

Maz's Perspective. Through this Critical Event from Maz's perspective, Maz was positioning herself as an expert in science by helping the classroom better understand radio energy. Furthermore, Maz was recognized for her intellectual work, contribution, and participation by Lulu when she described Maz as very attentive. Maz's identity work showed her high sense of self in science and was supported by being recognized by Lulu. This also showed self-recognition of expertise as Maz explained science ideas such as radio waves when publicly presenting.

Ella's Perspective. Through this Critical Event from Ella's perspective, Ella was being positioned by Maz as *not* an expert in science. Maz reinterpreted Ella's intellectual work; Maz felt like she needed to clarify. Furthermore, because Maz was recognized for her intellectual work, Ella did not have an opportunity to be recognized either by Lulu or herself.

Vignette 2: Another example, on February 2018, students were working on their poster for their ecosystem project. Ella did not have a role, so she wandered off to the white board to start drawing. At one point, Ella started writing on the whiteboard: "hi." Ella asked what she could do. Ignored, Ella grabbed a marker from the white board again. She drew on the whiteboard: "Hiii." Tessa told Ella to ask her group for a way to contribute to the poster. Ella then copied what Tessa said, "Zoe, how can I contribute to the poster?" Ignored again, Ella returned to drawing on the whiteboard. Tessa told her to work on the poster. Tessa asked Ella to move to the poster and contribute. Tessa asked if she wants to draw and asked Ella to contribute one thing on the poster. Alondra then made an announcement to the group about wrapping up. Zoe told Pedro not to use the bottom of the poster. Tessa said the group can write notes and then use the back. Ella said she is done with the job. Zoe said, “Ella doesn’t work hard like us and it isn't fair.” Ali expresses agreement with this.

Ella’s Perspective. Through this Critical Event from Ella’s perspective, Ella did not have a role and or opportunity to participate in the science activity. In fact, Ella signaled for opportunities to participate. Even when asked, Zoe ignored Ella and did not offer an opportunity for Ella to contribute. Ella was then positioned, by Zoe, as not a hard worker and not contributing fairly to the project.

Zoe’s Perspective. Through this Critical Event from Zoe’s perspective, Zoe was recognizing her own STEM engagement and accomplishments. When Ella first asked Zoe to make a contribution doing so would require Zoe to change her engagement patterns to support Ella. Furthermore, Zoe recognized herself when she positioned Ella as not engaging. Again, Zoe emphasized, “like us” when saying that Ella was not participating. Therefore, Zoe positioned herself as one of the “us” who engaged noting the unfairness of Ella’s lack of participation. From Zoe’s perspective, she was working hard, and Ella was the one who needed to find ways to contribute fairly to the group.

Summary of Findings

When the case study girls leverage cultural resources across settings and are recognized, they generate new meanings of self in science across four different themes. These four themes are 1) cultural resources and practices include language, 2) creating counter-spaces, 3) leveraging practices and tools from home, and 4) building relationships with educators. When comparing across cases, the girls’ engagement in STEM activities shifted based on having a productive role and on their relative recognition work.

Leveraged Cultural Resources for New Meanings of Self in STEM

First, language was leveraged as a resource for learning science in both English and in Spanish. For example, Maz was able to engage in scientific thinking by clarifying her thoughts in Spanish before presenting these ideas in English. Second, the after-school setting became a counter-space for the case study girls. In particular, the after-school space was a place to learn and engage with STEM while challenging the traditional rules and norms of the school setting for Ali. Ali was able to openly state that, in school, the research and science learning had no impact from her perspective. Third, practices and tools from home were leveraged across settings in the after-school space. For example, Zoe was able to leverage her time volunteering at the food pantry with her family in discussing access to healthy food and the energy needed to be healthy. Fourth, relationships and bonding time (*convivir*) between students and educators supported learning opportunities by making students feel like they belonged in the after-school program. For example, this setting became a space for Ali to bond with Lulu while listening to BTS and K-pop.

Roles and Recognition for New Meanings of Self in STEM

The first pattern from the cross-case analysis shows that students need a specific role to leverage resource and engage deeply in STEM activities. Ella and Ali both had difficulty participating in the activities because they did not have a role in their groups. Ella was given the roles toward the end of the activities but did not have a stable role throughout the project. Unlike Ella, Ali was able to carve out her own role in the activities and consistently take a part in that role. The second pattern from the cross-case analysis shows that recognition work is relative. In other words, recognition work in STEM activities is not simply about *who* is being recognized for their accomplishments. The other participations, positions, and structure of events have various impacts on the recognition work conducted and its outcomes. When I observed relative recognition work, there were differences in *who* was recognized, *what* was recognized, and *how* the person was recognized.

CHAPTER 6: DISCUSSION & CONCLUSIONS

Poco a poco se anda lejos (Little by little, one goes far):

Moving the Needle on Supporting Mexican American Girls STEM Identity Development

Road Map

This study sought to better understand the cultural resources and practices Mexican-American girls leverage to engage in STEM learning. In doing so, I explored how cultural resources and practices are leveraged and recognized by four Mexican-American girls in an after-school STEM program. In particular, I focused on their STEM identity development as an outcome of this process.

Based on these findings, I argue that 1) productive STEM identity development generates new roles and relationships and 2) recognition work is relative. In the following, I unpack this idea and highlight key patterns. Finally, I conclude with two recommendations for practice and two future directions for research.

Claim 1: Roles as Opportunities – Generating Identity Resources

I must acknowledge the obvious: students who do not have a role in the activity cannot leverage their resources. Therefore, having a role or responsibility becomes an identity resource when girls leverage and are recognized for their resources. Identity resources from roles are generated when girls: 1) take up a role for themselves, and 2) are able to generate an identity artifact that is referenced and thereby legitimized. Every part of student's engagement is a role: either a role as a productive person engaging deeply in the science activity or a role as a non-productive person engaging deeply in the science activity. As a result, when we compare and contrast the respective roles of Ali and Ella, we see 1) how they take up roles across multiple events consistently, and 2) how taking up roles generates identity resources. The identity resources that emerge from roles are resources to start, continue, and further participation in and engagement with STEM activities

Taking Up Roles by Herself Across Multiple Events Consistently.

One important note is how the roles that Ella and Ali took up either were consistent or inconsistent across time. For example, Ella's roles that she took on to participate in activities were one-off moment and failed to sustain her participation. In other words, Ella was able to leverage some of her cultural resources and practices when she had a role. However, when trying to find a way to contribute to the diorama of the forest ecosystem, Ella did not have a role. Maz was primarily worked the painting of the diorama and Pedro worked on identifying which of the animals belonged to the forest ecosystem (see Critical Event #10 on 03/08 on Table 5.3). Ella, meanwhile, had no role that carried across multiple events and was therefore unable to leverage resources across these events to generate identity resources. The inaccessibility of roles acted as barriers to her participation. In the end of some events, Ella was able to take up a role and leverage some of her cultural resources and practices. For example, during the diorama project, Ella was able to start contributing to the activity by making flowers for the ecosystem diorama using pool noodles. From there, Ella was able to leverage crafting resources that she engaged with at home with her mother. Ella even offered to bring ribbons for the next session to help add more to the forest diorama. However, in the following sessions, Ella did not have a role in which she could help with the diorama and leverage her crafting resources from home to generate her identity resources.

Like Ella, Ali initially did not have a role specific to her, but she was able to create a role for herself and take up these roles and make it a meaningful opportunity to generate her identity resources. This was possible because Ali was able to create a role for herself that was consistent over long periods of time. For example, when creating the self-extinguishing fire pit, Ali did not have a role in creation and production. Pedro did background research on the fire triangle and Maz worked on the prototype. Maz and Ella were in the same initial position in the same group; not having a role and therefore no opportunity to be able to leverage their resources. However, this changed for Ali when she was able to create the quiz and the worksheets and thus created alternative roles for herself in the group.

Generating Identity Artifacts to Legitimize Roles

Ali was able to generate an identity artifact (such as the quizzes and worksheets for her group) that gave her role legitimacy. With her artifacts, the roles that Ali took on were productive for the group because they contributed to the larger overall project. As a result of generating her identity resources, Ali was able to start, sustain, and continue her STEM participation by continuously drawing on and referencing her artifact. By referring to her artifact, her role was stabilized because there was evidence that it was productive and contributory. As a result of the quiz and the worksheet, Ali was able to leverage many of her in-school resources and challenge the power dynamics of what it means to participate in STEM activities. By generating identity resources, Ali was able to also challenge dominant narratives and power structures of the traditional learning environment to create counter-spaces. Rather than be complacent with her role, Ali exerted agency to carve out a new role for herself. Rather than become a product of the learning environment, Ali generated a role as an active member of the process of learning. Within the learning environment, Ali challenged who generated science knowledge. Therefore, Ali was able to generate identity resources to continue to use the quiz and worksheet, leveraging in school practices in the after-school setting. In doing so, Ali was recognized for refashioning and taking ownership of these school practices as this allowed her to participate in the group activity. One of the differences that set Ali apart from Ella was the fact that Ali was able to use the quiz and the worksheet to continuously legitimize her role across various Critical Events (see Critical Event #16-17 in Table 5.2). Because Ali was able to take on a role, one that she carved out herself across multiple Critical Events, she was able to legitimize her role in the group as a legitimate way of participation. By having a role, Ali was able to generate identity resources that opened up opportunities to be recognized and generate identity resources.

Summary of Identity Resources. As described above, having a role proved important, as taking on a role generated an identity resource. However, taking up new roles is difficult. In group settings, students participate based on the norms of specific roles (Cohen & Goodlad, 1994; Horn, 2005). Particularly in informal STEM education settings, structure, design, and roles both afford and constrain identity negotiations (Pattison, Gontan, Ramos-Montañez, & Moreno, 2018). However, even in group work, there rarely is an account for complicated peer worlds which foster unanticipated dynamics, including peer status (Christianakis, 2010). Taking up a new role requires changing practices, constructing new history of representations, and building new relationships (Wortham, 2005). For the girls in this case study, taking on a role was not simply having or not having a role.

Other researchers have described roles and actions one has in specific contexts as embodied identities-in-practice. Embodied indentities-in-practice are described as "performing who one is in specific contexts through one's actions and relationships with discourse, tools, and resources within social contexts (Tan et al., 2013, pg. 1148). The role that the girls in this case study take on are the embodied identities-in-practice, in the social context of the after-school program. A students' positon within a classroom, including the roles within the classroom community, impacts their participation and resilience when facing adversity (Fields & Enydey, 2013). The girls have roles that they take on – such as being someone who contributes and participates in keeping their goupmates in check with worksheets (i.e., Ali) or being someone who signals that they do not have a task by drawing on the white board (i.e., Ella).

In sum, not only does the notion of roles complicate how we understand participation and engagement, it also sheds light on the complicated process and negotiations that occur when leveraging resources. So far, little emphasis has been placed on student-to-student interactions within small groups that shape science identities (Gamez & Parker, 2017). When students are able to take on a role across multiple time points, they create opportunities for recognition work and development of STEM identities (Carlone & Johnson, 2012; Kane, 2011). As students layer on more meaning, with an active role, they are able to develop their sense of self and legitimize their roles as people who engage in activities.

Claim 2: Building Relationships – Generating Relational Identity Resources

As part of identity work, relationships are built between students and educators through *dichos* and *convivir*. Building relationships with Latinas in STEM through *dichos* and *convivir* honors the socio-cultural nature of identity development. This can in turn serve as a resource for supporting Latinas in their STEM meaning making. As a result of relationship building, either with other peers or educators, relational identity resources are generated. I define relational identity resources as those resources generated from identity negotiations to build, sustain, and initiate engagement in a learning environment.

***Convivir* as Relational Identity Resources.** When students and their educators are a part of *convivir*, they are engaging in conversations about K-pop, food from home, and play-acting about tacos. These conversations do not seem explicitly educational. But in each particular moment, educators cross the boundaries from being only an educator to also being a mentor, a friend, and someone with genuine interest and care students. These bonding moments build vulnerability and trust to generate relational identity resources. The bonding moments blurred the boundaries of the roles the adult educators held in the counter-space of the after-school program. Thus, the program became not just a place of learning but also a place where students and educators could be their authentic selves and build rapport.

For example, during all of the moments in which Lulu supported Ali for her K-pop interests, Lulu was standing up for someone who "reminds me of when I was little." In that moment, Lulu became extremely vulnerable of who she was when she was younger: someone who had many interests and was just trying to be themselves. Every moment in which Lulu defends Ali's interest in K-pop allows Lulu to become the person that she needed when she herself was younger. These moments also provide Ali with someone to step up and be there for her. Through those moments, the after-school program carved out as a space for Ali to be herself. These moments also enabled Ali to find other alternative roles and resources to leverage her engagement with STEM, for example creating posters to share science information, videos, worksheets, and quizzes for her group. It is only through those bonding moments, and the generation of relational identity resources, that Ali did not have to be afraid to be herself while engaging in STEM activities. This afforded Ali to the opportunity to feel welcomed in the after-school learning environment.

To seriously consider after-school STEM programs as counter-spaces for STEM engagement, relationships must be built by generating relational identity resources and making deep connections with students. Ultimately, there is an academic task at hand. However, within the setting of the after-school STEM program, the hierarchies and traditional school norms and rules do not apply. Instead, after-school programs become the counter-space in which fluid cultural resources and practices, STEM learning, and languages blur together.

***Dichos* as Relational Identity Resources.** This same trust and vulnerability emerge when teachers use *dichos* to support students and their learning. On the surface, these *dichos* might not seem like much. Simple phrases, such as *no te estreses* (don't stress), were not large pieces of data but had profound impacts. When Lulu used *dichos*, she leveraged the power of the home and legitimized the home-based practices of students. By doing so, this recognizes the importance of the cultural histories of Latinas and their families as a cultural resource. In doing so, relational identity resources are generated to sustain and support engagement in the after-school program. Again, the *dichos* are short phrases but carry on many meanings of resilience, empowerment, and histories of the community (Rodriguez-Rabin, 2005). These *dichos* have ties to the United Farm Workers and leaders such as Dolores Huerta who fought for civil rights and equity through large scale labor actions and strikes (Smith, 2017). In fact, leveraging *dichos* carries significant cultural and historical meaning to contemporary political struggles and activism in the U.S.

In its relation to learning STEM, *dichos* is a reminder of the importance of education and perseverance. As we saw with Zoe, she was able to collect herself and engage in the activity despite not having been there the last week in the after-school program. For Zoe, *dichos* became a connector of all the history of her community and family that lead her to this point to succeed in her endeavors. *Dichos*, as a cultural resource, provided opportunities for Zoe to engage in activities and generate relational identity resources to develop her STEM identity.

Summary of Generating Relational Identity Resources.

In sum, generating relational identity resources, through *dichos* and *convivir*, built, sustained, and initiated engagement in a learning environment. Through these two cultural resources, Lulu was able to build connections of trust and rapport. These positive relationships in context can increase one's connection to practice (Nasir, 2011). The figured world of the after-school space also includes the relationships that are built in the learning environment between students. Only when students feel like rapport is being built can the afterschool environment be porous and allow resources to be leveraged.

Claim 3: Complicating Recognition – Relative Recognition Work

To be clear, I am not arguing that either nobody should be recognized in fear of destabilizing others or everyone should be recognized for their accomplishments. If we fear that, by recognizing others we are destabilizing others, nobody would ever be recognized or have the opportunity to generate identity resources. Furthermore, if we recognize everyone for all of their accomplishments, recognition work becomes solely reliant on others and loses its power and legitimacy. It is critical to remember that, from a social practice theory perspective, everyone is engaging in identity work in the figured world of the after-school STEM program (Calabrese Barton et al., 2013) under certain social, cultural, and historical contexts (Wortham, 2005).

What researchers can learn from the analysis is that "everyone is a hero in their own story." Drawn from the remarks of the author of *A Game of Thrones*, George R.R. Martin, "nobody is a villain in their own story. We're all the heroes of our own stories" (Radish, 2017, para. 27). The literature on recognition work has emphasized self-recognition and recognition by others (Carlone & Johnson, 2007; Kane, 2011). Yet, in the literature of the subject and not the stories of the people who are also a part of these stories. In essence, the other actors engaging in identity work in the figured world of the after-school program have not been studied in relation to a focal person's identity work.

Taking on Perspectives through Relative Recognition Work

This dissertation points to the impacts of recognition on others and in stabilizing and destabilizing identities. The girls negotiated meaning and stabilized their own science identities in their own perspectives. However, in the process of stabilizing their own identities, they often destabilized those of others. Notably, this claim depends on who is the main character in the interpretation. Each girl strove to do her best in her own participation in the STEM after-school program. Depending on who is the main character, the same observation and event will have different interpretations in the figured world of the after-school STEM program. Each girl did not attempt to, out of spite, delegitimize and undermine another girl. The power of recognition cannot only stabilize one's identity but also destabilize another's identity in the same interaction and figured world.

All students in the case study had stories to live and tell. The students negotiated ways to find opportunities to participate. Nowhere in any of these stories, do the authors or case study girls position themselves as villians of the stories. In fact, each of them have stories of their own triumphs and ways of thriving. Each students' case opened with a quote reflective of a significant figure developing their own identities, a reflection of each girl. Through their own relative recognition work, the case study girls challenge the dominant narratives of what it means to be Latina in STEM.

For Maz, her case is parralleled to Gloria Anzaldúa and her semi-autobiography of *Borderlands / La Frontera: The New Mestiza. Like Anzaldúa*. Maz negotiates the different resources that are leveraged and recognized as identity resources. Again, being neither "*español* *ni inglés* [Spanish or English], but both." Maz is able to thrive in the border and be successful as a Latina, specifically a Mexican American girl, in STEM (Anzaldúa, 1987, p. 55). Maz was able to leverage Spanish as a language resource to participate and be recognized in science activities. The case of having to pick either STEM or being Latina. Furthermore, her case challenges deficit perspectives of Latinas in STEM by showing how Maz's cultural resources and practices support her success in STEM.

Ali's case parallels the K-pop group BTS and their story of #BTSLoveMyself. Following the ideas of stories, R.M. from BTS suggested at the UN General Assembly, "tell me your story. I want to hear your voice, and I want to hear your conviction" (Kim, 2018, para 20). With similar conviction, Ali was constantly rejected for her ideas, as a videographer, an artist, and a K-pop fan. Only through her own self love was she able to rise above her bullies and engage in STEM activities on her own terms, including her quiz and worksheets. Ali's case challenges dominant narratives of *who* is powerful in learning environments. Rather than being a product of learning, Ali was able to take ownership of her own learning and expertise. She kept her classmates accountable with her quiz and worksheets demonstrating her scientific knowledge. In doing so, she flipped the power dynamics of success in the STEM classroom.

For Ella, her case is paralleled to First Lady of the United States, Michelle Obama, and her autobiography *Becoming* (Obama, 2018). Like Obama, Ella is "still becoming, and this is the story of my journey" (Winfrey, 2018, para. 7.). Ella was positioned as someone still finding her voice, still trying to fit in, and still becoming – both as a Tongva and Mexican-American girl in STEM. There were many occasions that prevented Ella from generating identity resources which positioned her as someone who does not do science. Yet, Ella attempted to participate and gain recognition, though sometimes a bit too late. For example, Ella participated by finding the videos of the Yosemite fires. However, it was too late for her participation to be recognized. Ella challenged dominant narratives of what it means to *not* engage in learning activities. By drawing on the white board, she signaled for opportunities to participate. In traditional school and learning environments, Ella would be reprimanded and positioned as a “problem student.” Instead, Ella found new ways to participate.

For Zoe, her case is paralleled to Maya Angelou and her collection of poetry, *And Still I Rise*. Following the ideas of rising, Angelou’s poetry describes the ups and downs that occur (Angelou, 1978). In a very similar manner, Zoe found ways to rise up even when others brought her down. For example, when Pedro attempted to destabilize Zoe’s expertise in STEM, not only did Zoe restabilize herself through Pedro’s recognition, she also recognized her own STEM knowledge. Zoe challenged dominant narratives through her self-recognition work. Rather than depending on external actors for recognition, she recognized herself as a Latina capable of succeeding in STEM and making a positive impact on her community.

Summary of Relative Recognition Work

The literature has indicated the importance of recognition work as a powerful mediator of learning, developing, and maintaining a STEM identity. External recognition, from teachers, peers, and family, is key for students to develop a STEM identity (Packer & Goicoechea, 2000; Tosso, 2006). Often these are resources that afford recognition for students to position themselves as powerful participants (Jackson & Seiler, 2017). However, little is understood about the various conditions in which recognition work occurs.

Relative recognition work takes into account the various conditions and contexts in which recognition work stabilizes and destabilizes STEM identities. In other cases, resources that may have originally supported the development of a STEM identity may also lose their power over time. Resources that are no longer accessible to students may hinder their authoring of a STEM identity (Gonsalves, 2018). It is through the performance and recognition of those performances that a certain type of person is given context (Schwartz & Wade-Jaimes, 2018). Through this study, recognition work is understood within the wider context of power dynamics, accessibility, and the participation of other members of the community. Because of the subjective and relative nature of recognition work, students' positions are different.

In sum, the notion of recognition work as relative complicates how we understand and theorize recognition work. In fact, we undertheorize the implications of recognition and have focused on recognition work impacting and effecting the subject (i.e. the case study girl). What this dissertation sheds light on is how recognition work may also impact the classroom community (e.g. the other case study girls) which include the other actors in the activity.

Implications

Implication for Practice for Latinas in STEM Engagement

Recommendation 1: Having Self Selected or Predetermined Roles. As described in Claim 1, roles consistently over time can support students to generate new ways of participating in STEM related activities. Students can have roles that are predetermined by the learning designer. For example, the curriculum used in this after-school program had roles that were needed to accomplish the tasks. However, the UCI educators were also flexible and allowed students to change their roles and self-select new ways of engagement.

Recommendation 2: Building on Authentic Relationships and Moments of Joy and Bonding. As seen in Claim 2, relationship-building via bonding and rapport can support students to be their authentic selves. Language was used to communicate to the case study girls as people, in particular as Latinas, not just students. There were moments of bonding, moments of frustration, and moments of trying to support engagement. The educators built authentic relationships with the girls in the case study. As an outcome, these girls were able to trust their UCI educators. Building authentic relationships and trust may look very different from relationship to relationship and necessarily varies across context. What I suggest is taking times to build bonding moments, *convivir,* with students outside of the normal disciplinary practices of school and learning.

Recommendation 3: Minimize Comparative Recognition. As described in Claim 3, recognition work may have consequences for others. This can be particularly seen when we recognize either others or ourselves at the expense of others. This recommendation is tied to empathy and self-awareness. Recognition work should come from empathy and self-awareness. When we are empathetic, we care that our recognition can be destabilizing to others. When we are self-aware, we understand how our recognition may destabilize others. Recognition work should be focused on expertise in STEM while supporting others. One way to do this is to be critical of our recognition. Are we self-recognizing by putting others down? Are we recognizing others by comparing them to each other? To practice critical recognition, I suggest this work be based on the accomplishments of people and what they have produced, distinct from the potential lack of production by another person.

Implications for Future Research for Latinas in STEM Engagement

Complicating what it means to be Latina in STEM. As the literature review has pointed out, much of the literature conflates Latinas as a group. The context of what it means to be Latina can be broken down further into the various ethnic groups and across regions (e.g. Californian Mexican Americans vs. Arizonian Mexican Americans). Furthermore, there needs to be a challenge to better understand what it means for a Californian Mexican-American girl to be successful in STEM and under which conditions this can occur. There is no one set way of being a Latina in STEM. Therefore, this dissertation breaks up and widens the gap in understanding Latinas in STEM into the various heterogenous groups of Latinas in STEM. We further complicate the gap in the literature by reminding the field of the various and diverse ways Latinas in STEM can be represented. After breaking up that gap and widening it, this work aims to fill a more nuanced gap. This work contributes toward understanding Mexican-American girls in STEM activities across multiple settings. The hope is that future research remembers to disentangle the multiple meanings of STEM and multiple ways of being Latina.

REFERENCES

Allen, C. D., & Eisenhart, M. (2017). Fighting for desired version of a future self: How young women negotiated STEM-related identities in the discursive landscape of educational opportunities. *Journal of the Learning Sciences, 26*(3), 401–436. doi:10.1080/10508406.2017.1294985

Anderhag, P., Wickman, P.-O., Bergqvist, K., Jakobson, B., Hamza, K. M., & Säljö, R. (2016). Why do secondary school students lose their interest in science? Or does it never emerge? A possible and overlooked explanation. *Science Education*, *100*(5), 791–813. doi:10.1002/sce.21231

Anderson, I., Kagwesage, A. M., & Rusanganwa, J. (2013). Negotating meaning in multilingual group work: A case study of higher education in Rwanda. *International Journal of Bilingual Education and Bilingualism*, *16*(4), 436–450. doi:10.1080/13670050.2012.695771

Angelou, M. (1978). *And still I rise*. New York, NY: Random House.

Anzaldúa, G. (1987). *Borderlands / la frontera: The new mestiza*. San Francisco, CA: Aunt Lute Books.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). “Doing” science versus “being” a scientist: Examining 10/11-year-old schoolchildren’s constructions of science through the lens of identity. *Science Education*, *94*(4), 617–639. doi:doi:10.1002/sce.20399

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). “Balancing acts”: Elementary school girls’ negotiations of femininity, achievement, and science. *Science Education*, *96*(6), 967–989. doi:10.1002/sce.21031

Arreguín-Anderson, M. G., & Ruiz-Escalante, J. A. (2018). Adivinanzas and dichos: Preparing prospective educators to teach science by incorporating culturally responsive tools. *Journal of Latinos and Education*, *17*(1), 84–91. doi:10.1080/15348431.2016.1257427

Aschbacher, P. R., Ing, M., & Tsai, S. M. (2014). Is science me? Exploring middle school students' STE-M career aspirations. *Journal of Science Education and Technology*, *23*(6), 735-743. doi:10.1007/s10956-014-9504-x

Aschbacher, P. R., Li, E., & Roth, E. J. (2009). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. *Journal of Research in Science Teaching*, *47*(5), 564–582. doi:10.1002/tea.20353

Ballenger, C. (1997). Social identities, moral narratives, scientific argumentation: Science talk in a bilingual classroom. *Language and Education*, *11*(1), 1–14. doi:10.1080/09500789708666715

Becerra, R. (2011). The Mexican American family. In R. Wright, C. H. Mindel, T. Van Tran, & R. W. Habenstein (Eds.), *Ethnic families in America: Patterns and variations* (p. 95). New York, NY: Elsevier.

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.), *Handbook of theory of research for the sociology of education* (pp. 241–258). New York, NY: Greenwood Press.

Briseño-Garzón, A. (2013). More than science: Family learning in a Mexican science museum. *Cultural Studies of Science Education*, *8*(2), 307–327. doi:10.1007/s11422-012-9477-0

Briseño-Garzón, A., & Anderson, D. (2012). "My child is your child": Family behavior in a Mexican science museum. *Curator: The Museum Journal*, *55*(2), 179–201. doi:10.1111/j.2151-6952.2012.00139.x

Brown, S., & Souto-Manning, M. (2007). 'Culture is the way they live here': Young Latin@s and parents navigate linguistic and cultural borderlands in U.S. schools. *Journal of Latinos *and Education*, *7*(1), 25–42. doi:10.1080/15348430701693374

Bruna, K. R. (2007). Traveling tags: The informal literacies of Mexican newcomers in and out of the classrooms. *Linguistics and Education*, *18*(3–4), 232–237. doi:10.1016/j.linged.2007.07.008

Bruna, K. R., & Chamberlin, D. (2008). Illuminated by the shadow: U.S.-Mexico schooling and pedagogies of place. *Multicultural Perspective*, *10*(3), 123–132. doi:10.1080/15210960802215458

Bunch, G. C. (2014). The language of ideas and the language of display: Reconceptualizing 'academic language' in linguistically diverse classrooms. *International Multilingual Research Journal*, *8*(1), 70–86. doi:10.1080/19313152.2014.852431

Burciaga, J. A., Christensen, C., & Christensen, T. (1997). *In few words/ en pocas palabras: A compendium of Latino folk wit and wisdom: A Bilingual collection*. San Francisco, CA: Mercury House.

Calabrese Barton, A., Ermer, J. L., Burkett, T. A., & Osborne, M. D. (2003). *Teaching Science for Social Justice*. New York, NY: Teachers College Press.

Calabrese Barton, A., Kang, H., Tan, E., O'Neill, T., Guerra-Bautista, J., & Brecklin, C. (2013). Crafting a future in science: Tracing middle school girls' identity work over time and space. *American Educational Research Journal*, *20*(1), 37–75. doi:10.3102/0002831212458142

Calabrese Barton, A., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching*, *46*(1), 50–73. doi:10.1002/tea.20269

Calabrese Barton, A., Tan, E., & Rivet, A. (2008). Creating hybrid spaces for engaging school science among urban middle school girls. *American Educational Research Journal*, *45*(1), 68–103. doi:10.3102/0002831207308641

Carlone, H. B., Johnson, A., & Scott, C. M. (2015). Agency amidst formidable structures: How girls perform gender in science class. *Journal of Research in Science Teaching*, *52*(4), 474–488. doi:10.1002/tea.21224

Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge- and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching*, *48*(5), 459–485. doi:10.1002/tea.20413

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. doi:10.1002/tea.20237

Carlone, H. B., & Johnson, A. (2012). Unpacking 'culture' in cultural studies of science education: Cultural difference sersus cultural production. *Ethnography and Education*, *7*(2), 151–173. doi:10.1080/17457823.2012.693691

Carlone, H. B., Scott, A., & Lowder, C. (2014). Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science. *Journal of Research in Science Teaching*, *51*(7), 836–869. doi:10.1002/tea.21150

Carspecken, P. F. (1996). *Critical ethnography in educational research: A theoretical and practical guide*. New York and London: Routledge.

Carspecken, P. F., & Walford, G. (2001). *Critical ethnography and education* (JAI, ed.). Amsterdam.

Carter, T. P., & Chatfield, M. L. (1986). Effective bilingual schools: Implications for policy and practice. *American Journal of Education*, *95*(1), 200–232. doi:10.1086/444297

Chan, N. N., Walker, C., & Gleaves, A. (2015). An exploration of students' lived experiences of using smartphones in diverse learning contexts using a hermeneutic phenomenological approach. *Computers & Education*, *82*, 96–106. doi:10.1016/j.compedu.2014.11.001

Christian, B., & Bloom, D. (2004). Learning to read is who you are. *Reading Writing Quarterly*, *20*(4), 365–384. doi:10.1080/10573560490489847

Christianakis, M. (2010). "I don't need your help!" Peer status, race, and gender during peer writing interactions. *Journal of Literacy Research*, *42*(4), 418–458. doi:10.1080/1086296X.2010.525202

Cohen, E. G., & Goodlad, J. I. (1994). *Designing groupwork: Strategies for the heterogeneous classroom*. New York, NY: Teachers College Press.

Cole, M., & Engeström, Y. (1997). A cultural-historical approach to distributed cognition. In *Distributed cognitions: Psychological and educational consideration* (pp. 1–46). New York, NY: Cambridge University Press.

Creese, A., & Blackledge, A. (2010). Translanguaging in the bilingual classroom: A pedagogy for learning and teaching. *Modern Language Journal, 94*, 103–115. doi:10.1111/j.1540-4781.2009.00986.x

Daiute, C. (2005). Youth genre in the classroom: Can children's and teachers' cultures meet? In J. Flood, S. B. Heath, & D. Lapp (Eds.), *Handbook of research on teaching Literacy through the Communicative and visual Arts: Sponsored by the International reading Association* (pp. 323–334). New York, NY: Lawrence Erlbaum Associates.

Davis, K., & Singh, S. (2015). Digital badges in afterschool learning: Documenting the perspectives and experiences of students and educators. *Computers & Education*, *88*, 72–83. doi:10.1016/j.compedu.2015.04.011

Delgado-Gaitan, C. (1994). Consejos: The power of cultural narratives. *Anthropology and*

Education Quarterly, *25*(3), 298–316. doi:10.1525/aeq.1994.25.3.04x0146p

Delgado-Gaitan, C. (2005). Family Narratives in Multiple Literacies. *Anthropology & Education Quarterly*, *36*(3), 265– 272. doi:10.1525/aeq.2005.36.3.265

Delgado Bernal, D., & Elenes, C. A. (2011). Chicana feminist theorizing: Methodologies, pedagogies, and practices. In R. R. Valencia (Ed.), *Chicano school failure and success: Past, present, and future* (3rd ed., pp. 99–119). New York, NY: Routledge Press.

Dominguez, M. V., Allexsaht-Snider, M., & Buxton, C. (2018). Connecting soccer to middle school science: Latino students' passion in learning. *Journal of Latinos and Education*, *17*(3), 225–237. doi:10.1080/15348431.2017.1319368

Durand, T. M. (2011). Latina mothers' cultural beliefs about their children, parental roles, and education: Implications for effective and empowering home-school Partnership. *The Urban Review*, *43*(2), 255–278. doi:10.1007/s11256-010-0167-5

Dyson, A. H. (1993). *Social worlds of children learning to write in an urban primary school*. New York, NY: Teachers College Press.

Eisenhart, M. (2000). Boundaries and selves in the making of "science". *Research in Science Education*, *30*(1), 43–55. doi:10.1007/BF02461652

Ek, L. D. (2009). "It's different lives": A Guatemalan American adolescent's construction of ethnic and gender identities across educational contexts. *Anthropology and Education Quarterly*, *40*(4), 405–420. doi:10.1111/j.1548-1492.2009.01061.x.

Elenes, C. A., González, F. E., Bernal, D. D., & Villenas, S. (2001). Introduction: Chicana/Mexicana feminist pedagogies: Consejos, respeto, y educación in everyday life. *International Journal of Qualitative Studies in Education*, *14*(5), 595–602. doi:10.1080/09518390110059900

Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. *Ergonomic*, *43*(7), 960–970. doi:10.1080/001401300409143

Espinoza-Herold, M. (2007). Stepping beyond sí se puede: Dichos as a cultural resource in mother–daughter interaction in a Latino family. *Anthropology & Education Quarterly*, *38*(3), 260–277. doi:10.1525/aeq.2007.38.3.260

Fields, D., & Enydey, N. (2013). Picking up the mantle of "expert": Assigned roles, assertion of identity, and peer recognition within a programming class. *Mind, Culture, and Activity*, *20*(2), 113–131. doi:10.1080/10749039.2012.691199

Flores, N. (2013). Silencing the subaltern: Nation-state/colonial governmentality and bilingual education in the United States. *Critical Inquiry in Language Studies*, *10*(4), 263–287. doi:10.1080/15427587.2013.846210

Freehill, L. M., Di Fabio, N. M., Hill, S. T., Traeger, K., & Buono, J. (2007). Review of the 2007 literature women in engineering. *SWE Magazine of the Society of Women Engineers, 54*(3), 6–27.

Gamez, R., & Parker, C. A. (2017). Become science learners: A study of newcomers' identity work in elementary school science. *Science Education*, *10*(2), 377–413. doi:10.1002/sce.21323

Gándara, P. C. (1995). *Over the ivy walls: The educational mobility of low-income Chicanos*. Albany, NY: State University of New York Press.

Garcia, G. E. (1994). Assessing the literacy development of second-language students: A focus on authentic assessment. In K. Spangenberg-Urbschat & P. Robert (Eds.), *Kids come in all languages: Reading instruction for ESL students*. Newark, DE: International Reading Association.

García, O., & Wei, L. (2013). *Translanguaging: Language, bilingualism and education*. New York, NY: Palgrave Macmillan.

Garza, E., & Arreguín-Anderson, M. G. (2018). Developing scientific inquiry in a dual language classroom. *Bilingual Research Journal*, *41*(2), 101–116. doi:10.1080/15235882.2018.1451790.

Gee, J. P. (2000). The new literacy studies: From ‘socially situated’ to the work of the social. In D. Barton, M. Hamilton, & R. Ivanič (Eds.), *Situated literacies: Reading and writing in context* (pp. 180–196). New York, NY: Routledge.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago, IL: Aldine Publishing Company.

Gonsalves, A. J. (2018). Exploring how gender figures the identity trajectories of two doctoral students in observational astrophysics. *Physical Review Physics Education Research*, *14*, 1–15. doi:10.1103/PhysRevPhysEducRes.14.010146

Gonsalves, A. J., Rahm, J., & Carvalho, A. (2013). We could think of things that could be science”: Girls’ re-figuring of science in an out-of-school-time club. *Journal of Research in Science Teaching*, *50*(9), 1068–1097. doi:10.1002/tea.21105

González, N., Andrade, R., Civil, M., & Moll, L. (2001). Bridging funds of distributed knowledge: Creating zones of practices in mathematics. *Journal of Education for Students Placed at Risk*, *6*(1&2), 115–132. doi:10.1207/S15327671ESPR0601-2_7

Groden, S., Kutz, E., & Zamel, V. (1993). *The discovery of competence: Teaching and learning with diverse student writers*. Portsmouth, NH: Heinemann.

Gumperz, J. J. (1982). *Discourse strategies*. Cambridge, UK: Cambridge University Press.

Gurung, B., & Rutledge, D. (2014). Digital learners and the overlapping of their personal and educational digital engagement. *Computers & Education*, *77*, 91–100. doi:10.1016/j.compedu.2014.04.012

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher*, *32*(5), 19–25. doi:10.3102/0013189X032005019

Gutiérrez, K. D., Rymes, B., & Larson, J. (1995). Script, counter script, and underlife in the classroom: James Brown versus Brown v. The Board of Education. *Harvard Educational Review*, *65*(3), 445–471. doi:10.17763/haer.65.3.r16146n25h4mh384

Gutiérrez, M. V., Willey, C., & Khisty, L. L. (2011). (In)equitable schooling and mathematics of marginalized students: Through the voices of urban Latinas/os. *Journal of Urban Mathematics Education*, *4*(2), 26–43.

Halmari, H., & Smith, W. (1994). Code-switching and register shift: Evidence from Finnish-English child bilingual conversation. *Journal of Pragmatics*, *21*(4), 427–445. doi:10.1016/0378-2166(94)90013-2

Hawkins, M. R., & Mori, J. (2018). Considering "trans-" perspectives in langauge theroies and practices. *Applied Linguistics*, *39*(1), 1–8. doi:10.1093/applin/amx056

Herman, T. (2018). BTS' UNICEF "Love Myself" campaign raises over $1.4 Million. Retrieved from Billboard website: https://www.billboard.com/articles/news/bts/8483029/bts-unicef-love-myself-campaign-money-raised

Herrenkohl, L. R., & Cornelius, L. (2013). Investigating elementary students' scientific and historical argumentation. *Journal of the Learning Sciences*, *22*(3), 413–461. doi:10.1080/10508406.2013.799475

Hilke, D. D. (1987). Museums as resources for family learning. Turning the question around. *The Museologist*, *50*, 14–15.

Hirst, E., & Renshaw, P. D. (2004). Diverse voices, dialogue and intercultural learning in a second language classroom. In J. van den Linden & P. Renshaw (Eds.), *Dialogic Learning: Shifting Perspectives to Learning, Instruction, and Teaching* (pp. 87–107). Netherlands.

Holland, D., Lachicotte Jr., W. S., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural words*. Cambridge, MA: Harvard University Press.

Holland, D., & Lave, J. (2009). Social practice theory and the historical productions of persons. *Action: An International Journal of Human Activity Theory*, *21*(5), 1–15. doi:10.1007/978-981-13-6826-4_15

Holland, D., & Leander, K. (2004). Ethnographic studies of positioning and subjectivity: An introduction. *Ethos*, *32*(2), 127–139. doi:10.1525/eth.2004.32.2.127

Horn, I. S. (2005). Learning on the job: A situated account of teacher learning in high school mathematics departments. *Cognition and Instruction*, *23*(2), 207–236. doi:10.1207/s1532690xci2302_2

Hursh, D. W., & Henderson, J. A. (2011). Contesting global neoliberalism and creating alternative future. *Discourse*, *32*(2), 171–185. doi:10.1080/01596306.2011.562665

Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., Lowe, S. M., & Woodson, K. M. (2018). (Un)Hidden figures: A synthesis of research examining the intersectional experiences of Black women and girls in STEM education. *Review of Research in Education*, *42*(1), 226–254. doi:10.3102/0091732X18759072

Irizarry, J. G., & Raible, J. (2011). Beginning with El Barrio: Learning from exemplary teachers of Latino students. *Journal of Latinos & Education*, *10*(3), 186–203. doi:10.1080/15348431.2011.581102

Ishimaru, A. M., Barajas-López, F., & Bang, M. (2015). Centering family knowledge to develop children's empowered mathematics identities. *Journal of Camily Diversity in Education*, *1*(14), 1–21.

Jackson, P. A., & Seiler, G. (2017). Identity work in the college science classroom: The case of two successful latecomers to science. *Science Education*, *101*(5), 716–740. doi:10.1002/sce.21290

Jiménez, R. T. (2000). Literacy and the identity development of Latina/o students. *American Educational Research Journal*, *37*(4), 971–100. doi:10.3102/00028312037004971

Kamberelis, G. (2001). Producing heteroglossic classroom (micro)cultures through hybrid discourse practice. *Linguistics and Education*, *12*(1), 85–125. doi:10.1016/S0898-5898(00)00044-9

Kane, J. M. (2011). Young African American children constructing academic and disciplinary identities in an urban science classroom. *Science Education*, *96*(3), 457–487. doi:doi:10.1002/sce.20483

Kane, J. M. (2016). Young African American boys narrating identities in science. *Journal of Research in Science Teaching*, *53*(1), 95–118. doi:doi:10.1002/tea.21247

Kang, H., Calabrese Barton, A., Tan, E., Simpkins, S. D., Rhee, H., & Turner, C. (2019). How do middle school girls of color develop STEM identities? Middle school girls' participation in science activities and identification with STEM careers. *Science Education*, *103*(2), 418–439. doi:10.1002/sce.21492

Kayumova, S., Karsli, E., Allexsaht-Snider, M., & Buxton, C. (2015). Latina mothers and daughters: Ways of knowing, being, and becoming in the context of bilingual family science workshops. *Anthropology & Education Quarterly*, *46*(3), 260–276. doi:10.1111/aeq.12106

Keys, C. W. (2000). Investigating the thinking processes of eight grade writers during the composition of a scientific laboratory report. *Journal of Research in Science Teaching*, *37*(7), 676–690.

Khisty, L. L. (1995). Making inequality: Issues of language and meanings in mathematics teaching with Hispanic students. In W. G. Secada, E. Fennema, & L. B. Adajian (Eds.), *New Directions for Equity in Mathematics Education* (pp. 279–292). Cambridge, UK: Cambridge University Press.

Kim, N. J. (2018). "We have learned to love ourselves, so now I urge you to "speak yourself."" Remarks by BTS' Kim Nam Jun (RM) at the launch of Generation Unlimited, at the UN General Assembly. Retrieved from https://www.unicef.org/press-releases/we-have-learned-love-ourselves-so-now-i-urge-you-speak-yourself

Kozinets, R. V. (2010). *Netnography: Doing ethnographic research online*. Thousand Oaks, CA: SAGE.

Leander, K. M. (2002). Polycontextual construction zones: Mapping the expansion of schooled space and identity. *Mind, Culture, and Activity*, *9*(3), 211–237. doi:10.1207/S15327884MCA0903_04

Leander, K. M. (2004). "They took out the wrong context": Uses of time-space in the practice of positoning. *Ethos*, *32*(2), 188–213. doi:10.1525/eth.2004.32.2.188

Lee, O., & Buxton, C. A. (2013). Integrating science and English proficiency for English language learners. *Theory Into Practice*, *52*(1), 36–42. doi:10.1080/07351690.2013.743772

Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English backgrounds. *Educational Researcher*, *27*(4), 12–21. doi:10.3102/0013189X027004012

Lefebvre, H. (1991). *The production of space*. Cambridge, MA: Blackwell.

Lemke, J. (1991). *Talking science: Laguage, learning, and values*. Norwood, NJ: Ablex Publishing Corporation.

Leung, B. (2019). Revolting against expectations, Learning self-love. Retrieved from The Fordham Ram website: https://fordhamram.com/68679/culture/revolting-against-expectations-learning-self-love

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: SAGE Publications.

Liu, D. D., & Kang, H. (n.d.). *Generating identity resources: Supporting young Latina's development of a STEM identity*.

López, M. M., Ynostroza, A., Fránquiz, M. E., & Curiel, L. C. (2015). Cultural artifacts: Using artifacts: Using Sylvia and Aki for opening up authoring spaces. *Bilingual Research Journal*, *38*(2), 190–206. doi:10.1080/15235882.2015.1068243

LópezLeiva, C. A., Torres, Z., & Khisty, L. L. (2013). Acknowledging Spanish and English resources during mathematical reasoning. *Cultural Studies of Science Education*, *8*(4), 919–934. doi:10.1007/s11422-013-9518-3

Lucas, T., Henze, R. C., & Donato, R. (1990). Promoting the success of Latino language-minority students: An exploratory student of six high schools. *Harvard Educational Review*, *60*(3), 315–340. doi:10.17763/haer.60.3.0160105tt9kgkq51

Madison, D. S. (2004). Introduction to critial ethnography: Theory and method. In D. S. Madison (Ed.), *Critical Ethnography: Methods, Ethics, and Performance* (pp. 1–17). Thousand Oaks, CA: SAGE Publications.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. San Francisco, CA: Jossey-Bass Social & Behavioral Science Series.

Moje, E. B., Ciechanowski, K. M., Kramer Katherine, Ellis, L., Carrillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, *39*(1), 38–70. doi:10.1598/RRQ.39.1.4

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (2009). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory Into Practice*, *31*(2), 132–141. doi:10.1080/00405849209543534

Moya, P. M. L. (2000). Reclaiming identity. In P. M. L. Moya & M. Hames-García (Eds.), *Re-claiming identity: Realist theory and the predicament of postmodernism* (pp. 1–9). Berkeley, CA: University of California Press.

Nasir, Na'ilah Suad. (2011). *Racialized identities: Race and achievement among African American Youth*. Stanford, CA: Stanford University Press.

Nasir, Na'ilah Suad, & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research*, *76*(4), 449–475. doi:10.3102/00346543076004449

Nasir, Na'ilah Suad, Rosebery, A. S., Warren, B., & Lee, C. D. (2014). Learning as a cultural process: Achieving equity through diversity. In *The Cambridge Handbook of the Learning Sciences* (pp. 686–706). New York, NY: Cambridge University Press.

National Research Council. (2015). *Identifying and supporting productive STEM programs in out-of-school settings*. doi:10.17226/21740

National Science Foundation, & National Center for Science and Engineering Statistics. (2017). *Women, minorities, and person with disabilities in science and engineering*. Arlington, VA.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*.

Washington, DC.

Obama, M. (2018). *Becoming*. New York, NY: Crown Publishing Company.

Oppland-Cordell, S. (2013). Mathematics and racial identity co-construction in multiple sociopolitical contexts: A case study of a Latina undergraduate students from an urban community. *Journal of Urban Learning, Teaching, and Research*, *9*, 89–99.

Packer, M. J., & Goicoechea, J. (2000). Sociocultural and constructivist theories of learning: Ontology, not just epistemology. *Educational Psychologist*, *35*(4), 227–241. doi:10.1207/S15326985EP3504_02

Palmer, D. K., Mateus, R. A., Martínez, S. G., & Henderson, K. (2014). Reframing the debate on language separation: Toward a vision for translanguaging pedagogies in the dual language classroom. *The Modern Language Journal*, *98*(3), 757–772. doi:10.1111/modl.12121

Palmer, D., & Martínez, R. A. (2013). Teacher agency in bilingual spaces: A fresh look at preparing teachers to educate Latina/o bilingual children. *Review of Research in Education*, *37*, 269–297. doi:10.3102/0091732X12463556

Parker, C. (2014). Multiple influences: Latinas, middle school science, and school. *Cultural Studies of Science Education*, *9*(2), 317–334. doi:10.1007/s11422-014-9573-4

Pattison, S. A., Gontan, I., Ramos-Montañez, S., & Moreno, L. (2018). Identity negotiation within peer groups during an informal engineering education program: The central role of leadership oriented youth. *Science Education*, *102*(5), 978–1006. doi:10.1002/sce.21459

Poza, L. E. (2018). The language of ciencia: Translanguaging and learning in a bilingual science classroom. *International Journal of Bilingual Education and Bilingualism*, *21*(1), 1–19. doi:10.1080/13670050.2015.1125849

Radish, C. (2017). George R.R. Martin Interview GAME OF THRONES.

Rahm, J., & Moore, J. C. (2015). A case study of long-term engagement and identity-in-practice: Insights into the STEM pathways of four underrepresented youths. *Journal of Research in Science Teaching*, *53*(5), 768–801. doi:10.1002/tea.21268

Ramsdell, L. (2004). Language and identity politics: The linguistic autobiographies of Latinos in the United States. *Journal of Modern Literature*, *28*(1), 166–176.

Reyes, I. M. M. (2004). Functions of code switching in Schoolchildren's conversations. *Bilingual Research Journal*, *28*(1), 77–98. doi:10.1080/15235882.2004.10162613

Riojas-Cortez, M., Huerta, M. E., Flores, B. B., Perez, B., & Riojas Clark, E. (2008). Using cultural tools to develop scientific literacy of young Mexican American preschoolers. *Early Child Development and Care*, *178*(5), 527–537. doi:10.1080/03004430600851223

Roche, K., Ghazarian, S., & Fernandez-Esquer, M. (2011). Unpacking acculturation: Cultural orientations and educational attainment among Mexican-Origin youth. *Journal of Youth and Adolescence*, *41*(7), 920–931. doi:10.1007/s10964-011-9725-8

Rodriguez-Rabin, R. M. (2005). Dichos. In S. Oboler & D. J. González (Eds.), *The Oxford Encyclopedia of Latinos and Latinas in the United States*. Oxford, UK: Oxford University Press.

Rodriguez, A. (1998). Statement from Arturo S. Rodriguez, President, United Farm Workers of America, Celebrating Cesar Chavez's Birthday 3/31/98-La Paz, Keene, Calif. doi:https://ufw.org/es/Statement-from-Arturo-S-Rodriguez-President-United-Farm-Workers-of-America-Celebrating-Cesar-Chavez-s-Birthday-3-31-98-La-Paz-Keene-Calif-/

Rodriguez, S., Cunningham, K., & Jordan, A. (2017). STEM identity development for Latinas: The role of self- and outside recognition. *Journal of Hispanic Higher Education*, *18*(3), 1–19. doi:10.1177/1538192717739958

Rosebery, A. S., McIntyre, E., & Gonzalez, N. (2001). Connecting students' cultures to instruction. In N. Gonzalez, E. McIntyre, & A. S. Rosebery (Eds.), *Classroom diversity: Connecting curriculum to students' lives* (pp. 1–13). Portsmouth, NH: Heinemann.

Ryu, M. (2019). Mixing languages for science learning and participation: an examination of Korean-English bilingual learners in an after-school science-learning programme. *International Journal of Science Education*, *41*(10), 1303–1323. doi:10.1080/09500693.2019.1605229

Saldaña, J. (2014). *Thinking qualitatively: Methods of mind*. Thousand Oaks, CA: SAFE Publications.

Sayer, P. (2013). Translanguaging, Tex-Mex, and bilingual pedagogy: Emergent bilinguals learning through the vernacular. *TESOL Quarterly*, *47*(1), 63–88. doi:10.1002/tesq.53

Sayman, D. M. (2013). Quinceñeras and quadratics: Experiences of Latinas in state-supported residential schools of science and math. *Journal of Latinos and Education*, *12*(3), 215–230. doi:10.1080/15348431.2013.765805

Schademan, A. R. (2010). What does playing cards have to do with science? A resource-rich view of African American young men. *Cultural Studies of Science Education*, *6*(1), 361–380. doi:10.1007/s11422-010-9275-5

Schleppegrell, M. J. (2004). *The language of schooling: A functional linguistics perspective*. Mahwah, NJ: Lawrence Erlbaum Associates.

Schwartz, R., & Wade-Jaimes, K. (2018). "I don't think it's science:" African American girls and the figured world of school science. *Journal of Research in Science Teaching*, *56*(6), 679–706. doi:10.1002/tea.21521

Seiler, G. (2013). New metaphors about culture: Implications for research in science teacher preparation. *Journal of Research in Science Teaching*, *50*(1), 104–121. doi:10.1002/tea.21067

Sewell, W. H. (1999). The concept(s) of culture. In V. E. Bonnell (Ed.), *Cultural Turn: New Directions in the Study of Society and Culture*. Berkeley, CA: University of California Press.

Siegel, D. R., Esterly, J. ennife. E., Callanan, M. C., Wright, R., & Navarro, R. (2007). Conversations about science across activities in Mexican-descent families. *International Journal of Science Education*, *29*(12), 14477–1466. doi:10.1080/09500690701494100

Sirin, S. R. (2005). Socioeconomic status and academic achievement: a meta-analytic review of research. *Review of Educational Research*, *75*(3), 417–453. doi:10.3102/00346543075003417

Smith, R. P. (2017). Civil rights icon Dolores Huerta offers advice to a new generation of activists.

Soja, E. W. (1989). *Postmodern geographies: The reassertion of space in critical social theory*. London, UK: Verso.

Solis, G., & Callanan, M. (2016). Evidence against deficit accounts: Conversations about science in Mexican heritage families living in the United States. *Mind, Culture, and Activity*, *23*(3), 212–214. doi:10.1080/10749039.2016.1196493

Stevenson, A. D. (2015). “Why is this bilingual classroom… Hablamos mas Español?” Language choice by bilingual science students. *Journal of Latinos and Education*, *14*(1), 25–39. doi:10.1080/15348431.2014.944704

Stevenson, A. D., Gallard Martinez, Alejandro José Brkich, K. L., Flores, B. B., & Claeys, L. (2019). Latinas’ heritage language as a source of resiliency: Impact on academic achievement in STEM fields. *Cultural Studies of Science Education*, *14*(1), 1–13. doi:10.1007/s11422-016-9789-6

Tan, E., & Calabrese Barton, A. (2008). Unpacking science for all through the lens of identities-in-practice: The stories of Amelia & Ginny. *Cultural Studies of Science Education*, *3*(1), 43–71. doi:10.1007/s11422-007-9076-7

Tan, E., Calabrese Barton, A., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching*, *50*(10), 1143–1179. doi:10.1002/tea.21123

Tenebaum, H. R., & Callanan, M. A. (2008). Parents' science talk to their children in Mexican-descent families residing in the USA. *International Journal of Behavioral Development*, *32*(1), 1–12. doi:10.1177/0165025407084046

Thomas, J. (1993). *Doing critical ethnography*. Thousand Oaks, CA: SAGE Publications.

Thompson, J. (2014). Engaging girls' sociohistorical identities in science. *Journal of Learning Sciences*, *23*(3), 392–446. doi:10.1080/10508406.2014.888351

Tosso, K. L. (2006). Student engineers and engineer identity: Campus engineer identities as figured world. *Cultural Studies in Science Education*, *1*(2), 273–307. doi:10.1007/s11422-005-9009-2

Tricoglus, G. (2001). Living the theoretical principles of critical ethnography' in educational research. *Educational Action Research*, *9*(1), 135–148. doi:10.1080/09650790100200146

Turner, E. E., Gutiérrez, M. V., Simic-Muller, K., & Díez-Palomar, J. (2009). "Everything is math in the whole world": Integrating critical and community knowledge in authentic mathematical investigations with elementary Latina/o students. *Mathematical Thinking and*

Learning, *11*(3), 136–157. doi:10.1080/10986060903013382

Tytler, R., Osborne, J., Williams, G., Tytler, K., Clark, J. C., Tomei, A., & Forgasz, H. (2008). *Opening up pathways: Engagement in STEM across the primary-secondary school transition*. Canberra, Australia.

Urietta Jr., L. (2007). Figured worlds and education: An introduction to the special Issue. *The Urban Review*, *39*(2), 107–116. doi:10.1007/s11256-007-0051-0

Valdés-Fallis, G. (1978). Code switching and the classroom teacher. In *Language in Education: Theory and Practice*. Arlington, VA: Center for Applied Linguistics.

Valdes, G. (1996). *Con respeto. Bridging the distances between culturally diverse families and schools. An ethnographic portrait*. New York, NY: Teachers College Press.

Valenzuela, A. (1999). *Subtractive schooling: U.S.-Mexican youth and the politics of caring* (S. B. Heath, Ed.). Albany, NY: State University of New York Press.

Valeras, M., Pieper, L., Arsenault, A., Pappas, C. C., & Keblawe-Shamah, N. (2014). How science texts and hands-on explorations facilitate meaning making: Learning from Latina/o third graders. *Journal of Research in Science Teaching*, *51*(10), 1246–1274. doi:10.1002/tea.21173

Villenas, S. A. (2005). Between the telling and the told: Latina mothers negotiating rducation in new Borderlands. In J. Phillion, M. F. He, & F. M. Connelly (Eds.), *Narrative and Experience in Multicultural Education*. doi:10.4135/9781452204376.n5

Villenas, S., Godinez, F. E., Bernal, D. D., & Elenes, C. A. (2006). Chicanas/Latinas building bridges: An introduction. In D. D. Bernal, C. A. Elenes, F. E. Godinez, & S. Villenas (Eds.), *Chicana/Latina Education in Everyday Life: Feminista Perspectives on Pedagogy and Epistemology* (pp. 1–10). Albany, NY: SUNY Press.

Vomvoridi-Ivanović, E. (2012). Using culture as a resource in mathematics: The case of four Mexican-American prospective teachers in a bilingual after-school program. *Journal of Math Teacher Education*, *15*(1), 53–66. doi:10.1007/s10857-011-9201-0

Weinstein, J. N. (2008). A Postgenomic Visual Icon. *Science*, *319*(5871), 1772–1773. doi:10.1126/science.1151888

Wenger, É. (1998). *Communities of practice: Learning, meaning and identity*. New York, NY: Cambridge University Press.

Willey, C. (2008). Immigrant Latina mothers' participation in a community mathematization project. *Adults Learning Mathematics International Journal*, *3*(2), 29–40.

Winfrey, O. (2018). Michelle Obama gets candid with Oprah about her new memoir.

Wortham, S. (2005). *Learning identity: The joint emergence of social identification and academic learning*. Cambridge, UK: Cambridge University Press.

Yin, R. (2013). *Case study research: Design and methods*. Thousand Oaks, CA: SAGE Publications.

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, *8*(1), 69–91. doi:10.1080/1361332052000341006

Zeidler, D. L. (2016). STEM education: A deficit framework for the twenty first century? A sociocultural socioscientific response. *Cultural Studies of Science Education*, *11*(1), 11–26. doi:10.1007/s11422-014-9578-z

Zimmerman, H. T. (2012). Participating in science at home: Recognition work and learning in biology. *Journal of Research in Science Teaching*, *49*(5), 597–630. doi:doi:10.1002/tea.21014

APPENDIX A

Lesson Plans from After-school program

Unit 1: Where is there Energy Around Us?

A Next Generation Science Standards (NGSS) curriculum for 5^{th} graders

Authors: David Liu, Alondra Villegas, Carlos Henriquez, Lourdes (Lulu) Galindo, and Tessa Pulido

Last edited January 2018

Big Question: Where do we see the energy around us?

Overview: Students will describe the different components that make up our food. Students will then describe the various ways in which energy is around us through cycles. Finally, students will share through a media broadcast about energy use.

Objectives:
-Students will be able to describe how energy is derived from the food we eat
-Students will be able to organize different types of energy such as chemical, kinetic, and electrical energy.
-Students will be able to create a broadcast of how different types of energy interact with each other.

NGSS Standards Addressed:
PS1.A as found in 5 -PS1 - 1. Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.

5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]

5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.

Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

PS3.D: Energy in Chemical Processes and Everyday Life The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

Common Core Math Standards Addressed:
MP.2 Reason abstractly and quantitatively. (5-PS1-3)

MP.4 Model with mathematics. (5-PS1-3)

MP.5 Use appropriate tools strategically. (5-PS1-3)

Common Core Literacy Standards Addressed:

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-3)

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-PS1-3)

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-PS1-3)

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS3-1)

SL.5.5 Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-PS3-1)

Description of Lessons:

Lesson 1: Students will be going over matter and how even though invisible to the naked eye, it still exists and can be measured through other methods. We will have the students think up of different food items and break them down into their smaller components: ingredients. Even if they cannot see the individual ingredients due to the transformation the ingredients have undergone, the students will be able to comprehend that the items still exist in a new form.

Lesson 2: First have students understand how matter is conserved through an activity on cooking. We will weigh ingredients for each food, then mix up the ingredients, "bake" (microwave), weigh the final product, and finally serve. After, we will do an exercise on reading nutrition labels and building representative bar graphs out of Legos to show the amount of carbohydrates, sugars, protein, sodium and calories there are in foods from the school menu and one dinner meal of their choice.

Lesson 3: The goal of this lesson is to introduce the concept of energy in a broad sense before narrowing it down in the following lessons.

Lesson 4: Students will describe their school as an ecosystem by describing the living and nonliving things. They will assign roles for their documentary and work together in groups to record their respective school ecosystem. Students will film and edit their video documentaries.

Lesson 5: The goal of this lesson is to introduce the concept of energy in a broad sense before narrowing it down in the following lessons. By the second session, learn where we (as individuals) are in relation to the different energy cycles.

Lesson 6: The goal of this lesson is to introduce the concept of energy in a broad sense before narrowing it down in the following lessons. By the second session, learn where we (as individuals) are in relation to the different energy cycles.

Suggested Calendar				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Week 1 Lesson #1 Look up cookie ingredients	Lesson #1 Look up recipes for own recipes	Lesson #2 Measure ingredients	Lesson #2 Microwave ingredients	Lesson #2 Follow up nutrition and label recipe
Week 2 Lesson #3 Energy Poster	Lesson #3 Food Sources Activity	Lesson #4 Describe step by step process	Lesson #4 Finalize poster projects	Lesson #5 Discuss modes of communications
Week 3 Lesson #6 Figure out roles for news	Lesson #6 Record	Lesson #6 Record/Edit	Lesson #6 Record/Edit	Lesson #6 Presentations

Lesson 1

Activity Name: Hands on with Elements

Overview: Students will be going over matter and how even though invisible to the naked eye, it still exists and can be measured through other methods. We will have the students think up of different food items and break them down into their smaller components: ingredients. Even if they cannot see the individual ingredients due to the transformation the ingredients have undergone, the students will be able to comprehend that the items still exist in a new form.

Goals: The goal of this lesson is to understand matter can be detected even if not seen by the naked eye.

Materials:
- Snickerdoodle cookies
- Ingredient packets
- iPad

NGSS standards:
PS1.A as found in 5 -PS1 - 1. Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.

NGSS Practices: Introduce the concept of how different particles, whether we see them or not, are still existent. We will accomplish this by having the students think of different foods and brainstorming the ingredients that go into them. In doing so, they will understand that matter cannot be destroyed, but rather transform into other forms that can still be seen (5-PS1-1).

Procedure

I. Introduce the Concept that food is made of different foods that we cannot see (10 minutes)
   A. Ease into the snickerdoodle activity with a cookie survey and ask students what their favorite cookie is. Create a bar graph.
   B. One snickerdoodle cookie→ but many ingredients
      1. Pass out cookies to students
      2. What ingredients can we see, and which ones can't we see (5 min)
         a) Call on kids to speak to whole class
         b) Share list of ingredients in cookie
      3. List the ingredients while using the packets so the kids can follow along (5 minutes)

II. What are students' favorite foods? (30 minutes
   A. Create a bar graph
   B. What are the ingredients of food?
      1. Share your favorite food with group (3 min)

2. Have 2-3 kids share favorite food and why to the rest of the class (3 min)

C. What is inside (ingredients of food) by looking up recipes on iPad

1. Pick one favorite food at table (2 min)
2. Brainstorm ingredients in food (8 min)
3. Use iPad to look up ingredients and compare lists (12 min)
4. Have one group share all ingredients (2 min)

Lesson 2

Activity Name: Conservation of Matter and Looking at the Lunch Menu

Overview: First have students understand how matter is conserved through an activity on cooking. We will weigh ingredients for each food, then mix up the ingredients, "bake" (microwave), weigh the final product, and finally serve. After, we will do an exercise on reading nutrition labels and building representative bar graphs out of Legos to show the amount of carbohydrates, sugars, protein, sodium and calories there are in foods from the school menu and one dinner meal of their choice.

Goals: To understand how matter is conserved, meaning that the weight of the ingredients will be the same as the weight of all product. Additionally, to understand that how to read nutrition labels and communicate the amount of the carbohydrates, sugars, protein, sodium and calories in different foods using Legos to create a life-size bar graph.

Materials:

- GROCERY LIST (serves 15)
    - flour
    - Fine grain sea salt (pinch)
    - Nutmeg (pinch)
    - baking powder
    - 15 eggs
    - maple syrup
    - coconut oil (or butter), melted
    - vanilla extract
    - Soymilk
    - sugar
    - Lemon juice
- Microwave
- Legos
- iPads
- Nutrition labels for each food from August 31 meal on calendar
    - Should be in packets, a couple per table
- Hand sanitizer and napkins
- Plates and forks
- Mugs for microwaving
- Measuring utensils
- Food scale

Worksheets:
Part 1) Recipe guide + measurement chart
Part 2) Bar charts and daily recommended nutrients

NGSS standards:

1. 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. [Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.] [Assessment Boundary: Assessment does not include distinguishing mass and weight.]
2. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

NGSS Practices: Introduce the concept of how different particles, whether we see them or not, are still existent. We will accomplish this by having the students think of different foods and brainstorming the ingredients that go into them. In doing so, they will understand that matter cannot be destroyed, but rather transform into other forms that can still be seen (5-PS1-1).

Procedure

Pre-Set-Up:
- Set out ingredients
- Set out Legos

Procedure

I. Ask students: What do you think happens to all the particles when Lulu baked those cookies last week? How much do you think all those individual ingredients weight? What about the weight of the batter? Do you think the weight of all those cookies are the same as the ingredients? What does it mean if it does weigh the same? What does it mean when it doesn't? So, our Big Question of the hour is: Is the weight of all the individual substances added up equal to the weight of the final product? Does it change?
II. Set out ingredients and say we are going to weigh them, mix them, bake them, and reweigh them to show that matter is conserved, or that things will maintain their weight, even if they are broken down differently
III. Weigh ingredients and mix (recipe below, makes 1) (*see below for David's measurements)*
    a. In one DRY CUP
        i. 2 tablespoons flour (16 g)
        ii. 1 teaspoon cinnamon
        iii. Pinch of fine grain sea salt (0g)
        iv. Pinch of nutmeg (0g)
    b. In one WET CUP
        . 1 egg (55g)
        i. 2 tablespoons milk (31 g)
        ii. 1 ½ tablespoons maple syrup (32 g)
        iii. 1 tablespoon coconut oil (15 g)
        iv. ½ teaspoon vanilla extract (4g)
IV. Add wet into dry. Then add ½ teaspoon baking powder (2g)
V. For icing:

a. 1 tablespoons of coconut butter
b. 1 tablespoons milk
c. 1 tablespoons coconut sugar
d. ½ teaspoons lemon juice

VI. BREAK KIDS INTO PAIRS (each pair makes one)

VII. Have two cups

a. Mix DRY cinnamon roll ingredients in mug,
b. flour
c. Fine grain sea salt (pinch)
d. Nutmeg (pinch)
e. Sugar

VIII. Mix WET cinnamon roll ingredients in mug

a. maple syrup
b. coconut oil (or butter), melted
c. vanilla extract
d. Soymilk
e. Mix all together
f. add the baking powder last

IX. Microwave on high for 2 minutes.

a. In the meantime, mix all the icing ingredients in a small bowl.
b. Drizzle icing over hot cinnamon roll.

X. Go to break. We microwave them in cups

BREAK

XI. Re-weigh cinnamon rolls and show that they did not lose any mass.

a. Ask students: what is the total mass of all the raw ingredients (figure it out in a group)
b. Ask students. Does the mass of the cinnamon rolls equal to the mass of the sum of ingredients? What does that mean? Mass conserved!

XII. **Next activity:** clear materials and set out Legos and nutrition label packets

a. Explain how we want to investigate how much of carbohydrates, proteins, sugar, sodium and calories are in each meal.
b. The reason these micronutrients are important is because they give us energy, but our body only needs certain amounts of each type. What happens if you eat too much sugar and candy? How do you feel? What happens if you eat too much salty food? How do you feel? What happens if you eat too much and consume too many calories? How do you feel?
c. Have each group start with breakfast or break table groups in half and they can work on different meals (*ask what they prefer/see what time permits for)*

i. Ask students: Look up the nutritional facts for each of those food items on school lunch. Ask students what they had for breakfast today and what they had for dinner yesterday. Look up those nutritional facts too. Did the student under each, meet the needs, or over exceeded those recommended nutrients?

ii. Ask students to graph using Legos the amount of nutrients from their food they've consumed. Compare it to the graph of recommended nutrients

d. Why are we only looking at carbohydrates, fats and sugars?
    i. These are the main building blocks of energy and make up most foods we eat. They are bolded on nutrition labels because of government regulation.
e. Each Lego=1 gram. Have them complete each meal, take a picture of each graph

Appendix for Lesson 2

Measurements and notes done by David
In one DRY CUP
2 tablespoons flour (16 g)
1 teaspoon cinnamon
Pinch of fine grain sea salt (0g)
Pinch of nutmeg (0g)

In one WET CUP
1 egg (55g)
2 tablespoons milk (31 g)
1 ½ tablespoons maple syrup (32 g)
1 tablespoon coconut oil (15 g)
½ teaspoon vanilla extract (4g)

Add wet into dry. Then add ½ teaspoon baking powder (2g)

= 146 grams weighted in the cup
However, total weight when adding all parts = 155. I think this happened because I didn't scrape the cup all the way down and there were clumps on the bottom before I moved to the next step. I would suggest adding it all into one dry cup and one wet cup.

In the mug, the mixture weighed 624 g. After microwaving, it weighed 616 g. I am assuming that it decreased in weight because of the water vapor.

Kitchen Chemistry
Name: ___________
Name: ___________
Date: ___________

Big Question of the Day: Is the weight of all the individual ingredients added up equal to the weight of the final product? Does it change?
Directions:

1. Use one cup as a measuring cup, one cup as a dry ingredients cup, and another as a wet ingredients cup. Measure in the measuring cup and pour into the mixing cup. Anything in blue are instructions.
2. When measuring the ingredients, measure the weight of the cup first and put TARE. The scale will balance to not include the weight of the cup.

1. In the measuring cup, measure the dry ingredients and then pour into the dry ingredients cup.	
2 tablespoons of flour	The weight of the flour is _____ grams
1 teaspoon of cinnamon	The weight of the cinnamon is ___ grams
1 pinch of salt	The weight of the salt is ___ grams
1 pinch of nutmeg	The weight of the nutmeg is ___ grams
Using the numbers above, what is the weight of the dry ingredients? Flour + Cinnamon + Salt + Nutmeg = _______ grams. The weight of the dry ingredients in the dry cup is ____ grams. Are the two numbers same or different? Are you surprised by these two numbers?	
2. In the measuring cup, measure out wet ingredients and then pour into the wet ingredients cup.	
2 tablespoons of milk	The weight of the milk is _____ grams
1 ½ tablespoons of maple syrup	The weight of the maple syrup is _____ grams
1 tablespoon of coconut oil	The weight of the coconut oil is _____ grams
½ teaspoon of vanilla extract	The weight of the vanilla extract is _____ grams
Using the numbers above, what is the weight of the dry ingredients?	

Milk + Maple Syrup + Coconut oil + Vanilla extract = _______ grams. The weight of the dry ingredients in the wet cup is ____ grams. Are the two numbers same or different? Are you surprised by these two numbers?	
3. Mix the wet ingredients well and pour into dry ingredients.	
Weigh out ½ teaspoon of baking powder. Add to the wet and dry ingredient mixture	The weight of the baking powder is ____ grams.
Using the numbers, what is the weight of the mixture? Wet ingredients + Dry ingredients + Baking soda = ___ grams. The weight of the dry ingredients, baking soda mixture is ____ grams. Are the two numbers same or different? Are you surprised by these two numbers?	
After, we will then add heat to the mixture to cook it. What do you think will happen to the properties (state of matter, color, and hardness) of the mixture? Do you think the weight will change?	
4.Icing recipe: In a clean measuring cup, weight out and add the ingredients into another cup which will be the icing cup.	
Weigh out 1 tablespoon of coconut oil	The weight of the coconut oil is ____ grams.
Weigh out 1 tablespoon of milk	The weight of the milk is ____ grams.
Weigh out 1 teaspoon of sugar	The weight of the icing is ____ grams
Weigh out ½ teaspoon of lemon juice	The weight of the lemon juice is ____ grams.
Using the numbers, what is the weight of the icing? Coconut oil + milk + icing + lemon juice = ___ grams. The weight of the icing mixture is ____ grams. Are the two numbers same or different? Are you surprised by these two numbers?	

Nutrition Labels
Name:
Name:
Date:

Big Question: What makes up the food that we eat?
Directions:
1. Read the sample nutrition label and gather the information on the gram amount of carbohydrates, sugars and fats. Record these amounts in the table below
2. Search on the internet for nutrition labels that match the foods on the school lunch menu
3. Once completed, look for nutrition labels on the dinner food you had last night

Nutrition Label of Bagel
How many of each of these nutrients does a bagel have in grams?

1. Carbohydrates: ______grams
2. Fats: ____ grams
3. Sugars: ______grams

Nutrition Label for the School Lunch
How many of each of these nutrients does each item have in grams?

Breakfast: Breakfast burrito
1. Carbohydrates: ______grams
2. Fats: ____ grams
3. Sugars: ______grams

Lunch:
- Chicken Tenders
1. Carbohydrates: ______grams
2. Fats: ____ grams
3. Sugars: ______grams

Mixed Vegetable Crudités

1. Carbohydrates: ______grams
2. Fats: ____ grams
3. Sugars: ______grams

Oranges

1. Carbohydrates: ______grams 2. Fats: ____ grams 3. Sugars: ______grams Milk 1. Carbohydrates: ______grams 2. Fats: ____ grams 3. Sugars: ______grams
Dinner: Your choice! What did you eat for dinner last night? I ate: _______________ 1. Carbohydrates _____grams 2. Fats: _____grams 3. Sugars: _____grams I ate: _______________ 1. Carbohydrates: ______grams 2. Fats: _____grams 3. Sugars: _____grams

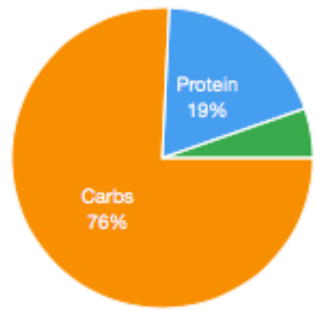
Whole wheat bagel

Nature's Own Bread

1 | bagel

Nutrition Facts	
For a Serving Size of 1 bagel (104g)	
Calories 230	Calories from Fat 13.5 (5.9%)
	% Daily Value *
Total Fat 1.5g	**-**
Polyunsaturated fat 1g	**-**
Sodium 360mg	**16%**
Carbohydrates 48g	**-**
Net carbs 41g	**-**
Fiber 7g	**29%**
Glucose 8g	
Protein 12g	
Vitamins and minerals	
Vitamin A 180µg	**20%**
Vitamin C 0mg	**0%**
Calcium 200mg	**20%**
Iron 1.6mg	**20%**
Fatty acids	
Amino acids	
* The Percent Daily Values are based on a 2,000 calorie diet, so your values may change depending on your calorie needs.	

Percent calories from...



Quick Stats:

48g Carbs
(41g net carbs)
1.5g Fat
12g Protein
230 Calories

No price info

Lesson 3

Activity Name: What is energy? Where can we find it? Where does it go?

Overview: Defining energy and its existence in everyday life

Goals: The goal of this lesson is to introduce the concept of energy in a broad sense before narrowing it down in the following lessons.

Materials:
- whiteboard
- Whiteboard markers
- tablets/laptops

NGSS standards:
PS3.D: Energy in Chemical Processes and Everyday Life The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

NGSS Practices: Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. (5-LS2-1)

Procedure

I. Start the lesson with asking the class what examples of science they see in their everyday life and relate this to their work last week (*2 minutes*)
   a. Transition into examples of energy in their everyday life (*3 minutes*)
      i. Students will brainstorm what energy means to them and how they see it in their lives
II. Have the students share with the rest of the class their examples of energy (*3 minutes*)
III. Then tell them what energy is by the broadest definition: "the ability to do work" or "the resources for producing power" and have it related back to all of the different examples they provided (*2 minutes*)
IV. Have the students work on an activity and draw up their own ideas of how the energy they see cycles through their environment (be it the body or ecosystem). (*15 minutes*)
   a. Be sure to give them a 5-minute warning
V. Write up the different examples on the board and sort them into categories (ex: ecosystems, electrical, nutrition, etc.) (*10 minutes*)
   a. Assign RAs to different categories
      i. *Tessa*- Nutrition/Chemical Energy

ii. *Alondra*- Solar Panel Energy/Electromagnetic Energy (mostly conversion of solar into electrical energy)
iii. *Carlos*- Gravitational
iv. *Lulu*- Electromagnetic Radiation (photosynthesis=conversion of electromagnet into chem energy)
v. *David*- Thermal Energy/Sound

VI. Create teams based on what examples the students provided; based on what type of energy without telling the students what category they fall under (*10 minutes*)

VII. Already have the laptops/tablets out for the groups that were created from the previous session (could be done during the break)

a. The objective is to identify and understand what type of energy the students are seeing in their everyday lives (*30 minutes*)
i. Use the tablets/laptops to research what type of energy their examples are (identify what category they fall under)
ii. Describe what this type of energy is and what do we know about it
1. How does it get here? What is the energy source? Is this type of energy similar to another type?
iii. Use PowerPoint to create a slideshow of their findings

VIII. Have the students share their PowerPoints to the rest of the class (*10 minutes*)

IX. Have them discuss what they think the purpose of energy is (What is it used for?) (*5 minutes*)

i.

Lesson 4

Activity Name: What is energy? Where can we find it? Where does it go?

Overview: Defining energy and its existence in everyday life

Goals: The goal of this lesson is to introduce the concept of energy in a broad sense before narrowing it down in the following lessons. By the second session, learn where we (as individuals) are in relation to the different energy cycles.

Materials:
- Whiteboard markers
- tablets/laptops
- markers/colored pencils
- Poster paper (large)
- Normal size printer paper

NGSS standards:
PS3.D: Energy in Chemical Processes and Everyday Life The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

NGSS Practices: Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. (5-LS2-1)

Procedure

A. Recap last week (5 minutes): What did we learn about energy last week? What is one thing we remember from last week?
B. Break up into groups from last week and continue working on the PowerPoints (30 minutes)
    a. The objective is to identify and understand what type of energy the students are seeing in their everyday lives
        i. Use the tablets/laptops to research what type of energy their examples are (identify what category they fall under)
        ii. Set a timer to keep track of the time and give the students warnings of the time remaining

**Bolded text is main focus for first session*

        iii. Describe what this type of energy is and what do we know about it
            1. What are the stages?
            2. What category is my kind of energy?

3. **How does it get from one stage to another stage?**
4. **Name a specific example of this energy in your everyday life**

iv. **Use PowerPoint to create a slideshow of their findings**

C. **Have the students share their PowerPoints to the rest of the class (15 minutes)**

Session 2: 5-5:45 PM

Pre-Setup: Have art supplies (poster paper, printer paper, coloring utensils, and laptops/tablets) ready at the tables before instruction. Can be set up during the break.

A. Have students discuss what they think the purpose of energy is (What is it used for? The ability to do work) in a general sense? Alright how about in each of your group's chosen category of energy? (5 minutes)
B. Now that we have looked at different energies, we want to know how we use the type of energy you decided to research. We now know that energy is all around us in different forms, but we want to have a better understanding of how we use it.
C. We are going to make posters, "draw-my-life" style projects or act it out to show ourselves using the energy we chose to research
   a. For example: Let's say I had chemical energy and I want to talk about what chemical energy is used in eating an apple
   b. Apple Example (5 minutes)
      i. Step 1: I eat an apple. I chew it in my mouth
      ii. Step 2: The apple bits are broken into smaller bits by my teeth
      iii. Step 3: The apple bits are broken down further into even smaller parts in my stomach, into nutrients
      iv. Step 4: These nutrients fuel my body. What can I do with these nutrients (run, jump etc.)?
D. After presenting the example, have the groups work on their own chosen project to present how they fit in with their energy. (30 minutes)
   a. *Be sure to set a timer and give out warnings to the students of the remaining time*
E. Once completing their skits/drawings, have the groups present their final project to the class.
   a. Only if time allows it

Lesson 5

Activity Name: What is energy? Where can we find it? Where does it go?

Overview: Defining energy and its existence in everyday life

Goals: The goal of this lesson is to introduce the concept of energy in a broad sense before narrowing it down in the following lessons. By the second session, learn where we (as individuals) are in relation to the different energy cycles.

Materials:
- Mac laptop for Facetiming (Session 2)
- iPhone: who has a good data plan/do we know if Wi-Fi reaches the pantry (Session 2)
- Art supplies (Session 1)
- Printed sheet of questions (Session 2)

NGSS standards:
PS3.D: Energy in Chemical Processes and Everyday Life The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

NGSS Practices: Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. (5-LS2-1)

Procedure

Pre-Set-Up: Have art supplies (poster paper, printer paper, coloring utensils, and laptops/tablets) ready at the tables before instruction. Can be set up during the break.
Troubleshoot Facetime for Session 2

A. Have the students discuss what they think the purpose of energy is (What is it used for? The ability to do work) in a general sense? Alright how about in each of your group's chosen category of energy? (5 minutes)
B. Now that we have looked at different energies, we want to know how we use the type of energy you decided to research. We now know that energy is all around us in different forms, but we want to have a better understanding of how we use it.
C. We are going to make posters, "draw-my-life" style projects or act it out to show ourselves using the energy we chose to research
    a. For example: Let's say I had chemical energy and I want to talk about what chemical energy is used in eating an apple
    b. Apple Example (5 minutes)

i. Step 1: I eat an apple. I chew it in my mouth
ii. Step 2: The apple bits are broken into smaller bits by my teeth
iii. Step 3: The apple bits are broken down further into even smaller parts in my stomach, into nutrients
iv. Step 4: These nutrients fuel my body. What can I do with these nutrients (run, jump etc.)?

**Bolded text and onward is the main focus for first session*

D. Have two TA's troubleshoot Facetime. (Carlos and someone else, during this time)
E. **After presenting the example, have the groups work on their own chosen project to present how they fit in with their energy.**
   a. ***Be sure to set a timer and give out warnings to the students of the remaining time***
F. Once completing their skits/drawings, have the groups present their final project to the class.
   a. Finish by 4:20 PM (20 minutes)
G. Wrap up end of Session 1 (10 minutes)
   a. What have we learned about our energy use?
   b. How has your view of energy changed since we learned about different types of energy and how we use them in everyday life?
H. Introduce topic for Session 2 (10 Minutes). Pass out guiding questions on board for Food Pantry while Carlos introduces topic (under Session 2)
   a. Split them into groups (chem + sound; chem + PE,KE)
   b. Explain Session 2: what Carlos is doing and what Tessa and TA's will be doing
      - Carlos explains where he is videoing and the questions they have to answer while watching Carlos
      - **TA's**: assign students questions based on previous energy group (assign food-based questions to people from chemical energy etc. Have a partner for questions)

Pre-Setup: Walk to Food Pantry and troubleshoot Facetime

A. Guiding Questions and Food Pantry visit (30 Minutes) * *Someone is facetiming in the Food Pantry**
   a. What are similarities and differences between where your energy is used?
   b. What foods do you see? Based on what you understand about healthy and unhealthy foods, which foods are healthy and unhealthy? How do you know?
      i. What does healthy food provide for our bodies that unhealthy food does not?
      ii. How does healthy and unhealthy food affect our energy levels?
         1. Think about how you feel after eating a sandwich versus candy
   c. What energy is being used to learn about the food pantry?
      i. How are we able to see Carlos in the food pantry right now?

ii. What energy is Carlos using to move around the food pantry?

B. I will ask the questions out loud to indicate what they should focus on
   a. EX: Ask Carlos to go closer to a piece of fruit and ask a food question. Indicate to kids the question on the board and prompt them to take notes

C. Have students discuss their answers within their groups.
   a. **TA's:** have them discuss answers and relate back to the big question

D. Putting it all together (15 Minutes)
   a. Questionnaire
   b. Ask questions and record answers on board

Food Pantry: Guiding Questions

Big Idea: Think of examples of how the two energies in your group interact

1. What are similarities and differences between where your energy is used?
    a. Similarities: work together by using the energy from the food to bat … there was a lot of food,
    b. Difference: chemical energy = the person using it & the potential and kinetic =the object using the energy… there was healthy and unhealthy food… radio waves you don't see with the naked eye
2. What foods do you see? Based on what you understand about healthy and unhealthy foods, which foods are healthy and unhealthy? How do you know?
        i. Sausage, potatoes, onions, seafood sauce, bread, corned beef canned, bananas, peppers, milk, salad
    b. What does healthy food provide for our bodies that unhealthy food does not?
    c. How does healthy and unhealthy food affect our energy levels?
        i. How does healthy and unhealthy food affect the amount of physical energy
        ii. Think about how you feel after eating a sandwich versus candy
            1. Do you feel energetic for a short or long time after eating healthy vs unhealthy food?
                a. Feel the same
                b. Healthy food → more energy to play outside,
                c. Candy → not much energy
                d. Tummy hurts with unhealthy but not with the healthy foods

3. What energy is being used to learn about the food pantry?
    - Stored food energy,
    1. How are we able to see Carlos in the food pantry right now?
        a. Electrical energy, using camera and video chatting (laptop & cellphones)
        b. Radio waves
    2. What energy is Carlos using to move around the food pantry?
        a. Stored food energy

Questions

What are some modes of communications that you know? (ways you see people communicate)
- Online, with phones, verbally, newspaper, sign language

What are some ways you best learn new information? (readings, seeing, etc.)
- Faster in internet, but books are more helpful sometimes
- Media and internet
- experiences

What is some information about your different types of energy that you want others to know?
- Certain foods will affect your energy
- Some healthy foods have more nutritional value
- Staring at a screen for too long is bad?

- Soccer, rockets, baseball
    - Foods that you eat can affect the way you play sports. Bad food → will not do as well in sports.

What have we learned about the importance of food with relation to energy levels?

What is something you can create that shows knowledge about the two energies in your group?
- Broadcast
- Making a website
- tv/news show
- What to talk about
    - Food taste
- PowerPoint
- video

How can what you learned help others?

Lesson 6

Activity Name: Breaking News!

Overview: Broadcast the information about the type of energies that the groups have been studying & make everyday connections.

Goals: To have the students apply the knowledge they have gained from the previous lessons about energy and convey it through different modes (short broadcasting segment).

Materials:
- iPads
- Pencils & markers
- White paper
- Index cards
- Worksheets (instructions template)

NGSS standards:
PS3.D: Energy in Chemical Processes and Everyday Life The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

Energy and Matter: Energy can be transferred in various ways and between objects.
NGSS Practices:
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.

Procedure:

A. **RECAP last week's questionnaire** (5 minutes)
    a. Some modes of communication were:
        i. Online, with phones, Verbally, Newspaper, Sign language
    b. Some information about your different types of energy that you want others to know.
        i. Certain foods will affect your energy
        ii. Some healthy foods have more nutritional value, Foods that you eat can affect the way you play sports.

B. **INTRODUCE two new mini projects**: news podcast (10 minutes)
    a. OPTION 1: Explain what a podcast is to the students [5 min]

        i. Give the examples of WTNV and TAZ (explain that they're similar to radio talk shows but online)
   b. OPTION 2: news segment [5 min] Alondra
        i. For those that want to be in front of the camera, they can work in their teams to create a news segment
   c. *Make sure to notify the students that the segments should be 2 minutes max (less is fine)*

C. **EXPLAIN assignment guidelines** (5 minutes) lulu
   a. Go over guiding questions
        i. Must answer all the questions b. Go over roles
        ii. Assign tasks/roles

D. **WORK within groups on the final project** (25 minutes)
   a. Choose between option 1 or 2
   b. Assign roles amongst yourselves
        i. *Notify the students that they have 5 minutes to decide on an option and assign roles*
        ii. *After the 5 minutes, notify the groups and have them start on the actual project*
   c. Start by answering the questions to help formulate their scripts
        i. Do extra research if necessary
   d. Based on responses, can begin their practice "skits" before the actual filming
        i. Start the final product/filming

E. **FINISH working on mini project prep** (15 min) a. For those who are "done" with their scripts, have them practice before the filming

F. **FILM/RECORD their mini projects** (20 min)
   a. Use iPads for recording/filming
        i. Go over tech. Norms 1. Not a toy, be careful, only for project use

G. **PRESENT their mini projects** (15 min)
   a. Group Roles:
   b. Take turns watching or listening to each other's projects

MINI ENERGY PROJECT

Group Roles:

Name of Student	Role	Tasks

Instructions: Groups must answer all of the questions below

1. Give us some background on the two types of energies the groups have been studying.
2. How do the two types of energies apply to our everyday lives?
3. Where can we access these types of energy?
4. How can we improve the use of these energies?

Unit 2: How is Our School an Ecosystem?

A Next Generation Science Standards (NGSS) curriculum for 5th graders

Authors: David Liu, Alondra Villegas, Vanessa Comia, Steven Vu, Susana Reyes-Valdez
Last edited November 2017

Big Question: What are the nonliving and living things in an ecosystem and how do they interact?

Overview: Students will describe the nonliving and living things in their school ecosystem. Students will then produce a video that shows their school ecosystem while describing components such as the living organisms, non-living organisms, producers, consumers, and decomposers.

IMPORTANT: It is important to note, that this curriculum carries on to the "Engineering a Solution" lesson plans. In the next series of curriculum, students will review their videos and identify a problem in the ecosystem and how they can create change and design a solution.

Objectives:
-Students will be able to describe nonliving and living components of an organisms
-Students will be able to organize different organisms as composers, producers, and decomposers.
-Students will be able to create a story of their school ecosystem and its organisms and environment

NGSS Standards Addressed:
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Common Core Math Standards Addressed:
MP.4 Model with mathematics

Common Core Literacy Standards Addressed:
RI.5.7. Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or solve a problem efficiently.
SL.5.5 Include multimedia components (e.g. graphics, sounds), and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

Description of Lessons:

Lesson 1: Students will describe the school as an ecosystem by describing the living and non-living things. Students will then categorize their living things as either a producer, consumer, or decomposer.
Lesson 2: Students will describe their school as an ecosystem by describing the living and nonliving things in CBA. They will finish their community map, organism booklet, and begin creating their documentary
Lesson 3: Students will describe their school as an ecosystem by describing the living and nonliving things. They will assign roles for their documentary and work together in groups to record their respective school ecosystem. Students will film and edit their video documentaries.

Suggested Calendar				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Week 1 Lesson #1 Create community maps of the school	Lesson #1 Create the organisms in the school ecosystem	Lesson #2 Create organism legend and start a script and roles for video	Lesson #2 Continue script and roles for video	Lesson #3 Film
Week 2 Lesson #3 Film	Lesson #3 Film	Lesson #3 Edit	Lesson #3 Edit	Lesson #3 Present (Carries onto the engineering a design unit)

Lesson 1

Activity Name: The School as an Ecosystem

Overview: Students will describe the school as an ecosystem by describing the living and non-living things. Students will then categorize their living things as either a producer, consumer, or decomposer.

Goals: The goal of this lesson is to show students that their community is an ecosystem with living and non-living components.

Materials:

- School Ecosystem Map (1 per student)
- Draw your Organism worksheet (1 per student)
- Colored pencil and markers

NGSS standards:
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Procedure

I. Large group - Refresher with Ecosystem
    a. What do you remember about ecosystems from your science class?
    b. What are the different parts of an ecosystem?
    c. What are some of the living and nonliving components of an ecosystem?
        i. Terms: Living, nonliving, Producers, Consumers, Energy, Decomposers
II. Large group - Pokémon Go video
    a. https://www.youtube.com/watch?v=ud17EHiDKrM
    b. What types of Pokémon are shown?
        i. Water, birds, owls, and bats
    c. What types of environments are shown in the video?
        i. City, forest, mountains, beach
III. Mini Squads - The School Ecosystem using the Maps
        i. Community Map (Non-living things)
            1. The purpose of this task is for students to be able to see that the school is an ecosystem, emphasizing the nonliving things.
            2. Follow up questions
                a. Ask the students to draw a map of their school. What do they see every day? What are their daily routines?
                b. Ask students to list the non-living things in the school ecosystem ex. Trash can, tables, water, sand.

ii. School Organism Map (Living things) (Use draw your organism hand out)
    1. The purpose of this task is for students to understand how living things coexist with nonliving things in an ecosystem. Make sure to emphasize how the nonliving and living things relate to each other and support each other. For example, would an organism such as a fish live in the jungle gym?)
    2. Follow up questions
        a. What kind and types of organisms that would be in the school ecosystem?
        b. Where would we find them and why would they live there?
        c. Would they be a producer, decomposer, or consumer?
    3. Students can write down two entries about the organism in the ecosystems map.
    4. Be sure to foreshadow that next week we will be filming a video about how their school is an ecosystem and how they see the organisms they listed as part of the ecosystem.

School Ecosystem Map

What do you see every day at school?

What are the nonliving things you see at school?

Draw Your Organisms

Draw your organism that lives in your school ecosystem

Is it either a producer, consumer, or decomposer?

Where would it live in the school ecosystem?

How is it related to the living and non-living things?

Lesson 2

Activity Name: Brainstorming an Ecosystems Documentary

Overview: Students will describe their school as an ecosystem by describing the living and nonliving things in CBA. They will finish their community map, organism booklet, and begin creating their documentary

Goals: The goal of this lesson is to show students that their community is an ecosystem with living and nonliving components.

Materials:

- School Ecosystem Map (1 per student)
- Draw Your Organism (at least 6 organisms)
- Colored pencils and markers (David)
- Recording devices such as smart phones, tablets, video cameras

NGSS Standards:
-5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

NGSS Practices:
-Modeling in 3-5 builds on K-2 models and progresses to building and revising simple models and using models to represent events and design solutions.
-Develop a model to describe phenomena. (5-LS2-1)
-A system can be described in terms of its components and their interactions. (5-LS2-1)

Procedure

I. Organism Community Map
   -2 students pass out map and legends-
   - Teacher will divide students into 4 groups
   A. Students will finish up on their community maps
      1. Students have examples of the main components of an ecosystem, i.e. consumer, producer, decomposer - nonliving (abiotic) /living (biotic).
   B. Class Discussion
      1. Students will discuss as a class the different environments in the school that organisms can live in.
      2. The teacher will assign which group has which section (on map/whiteboard)
         a) Basketball court
         b) Jungle Gym
         c) Black Top
         d) Classroom
      3. Each group will choose one representative to discuss an organism that can live in their assigned environment

a) Organism name
b) Category (consumer, producer, decomposer)
c) Nonliving or living
d) Why/how the organism is related to their environment?

II. Organism Legend

A. Students will work in assigned groups to create an Organism Legend

1. Students will use the worksheet as a guideline to create or name an organism that would best fit at the school (drawing information from the community maps). *(Students must draw at least **6** organisms, at least **two** per category - **consumer, decomposer, and producer**)*
2. Students must describe how the organism they drew relates to the environment and how the organism interacts with their environment/other organisms around them.
3. Students must name their organism

Ex: Gary the Goat is a consumer that can live by the jungle gym because it eats grass.

III. Documentary Assignments

A. Teacher will write possible jobs on the whiteboard
B. Students will discuss amongst each other and assign jobs within group (people take turns) [EACH student must be in the video at least once]

1. Recorder
2. Organism
3. Narrator
4. Guide
5. Why organism is interrelated to environment/what category it falls under. (can be split)

Lesson 3

Activity Name: Producing the Video

Overview: Students will describe their school as an ecosystem by describing the living and nonliving things. They will assign roles for their documentary and work together in groups to record their respective school ecosystem.

Goals: The goal of this lesson is to show students that their community is an ecosystem with living and nonliving components.

Materials:

- School Ecosystem Map (1 per student)
- Draw Your Organism (at least 6 organisms)
- Colored pencils and markers (David)
- Recording devices such as smart phones, tablets, video cameras

NGSS Standards:
-5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

NGSS Practices:
-Modeling in 3-5 builds on K-2 models and progresses to building and revising simple models and using models to represent events and design solutions.
-Develop a model to describe phenomena. (5-LS2-1)
-A system can be described in terms of its components and their interactions. (5-LS2-1)

Procedure

I. Groups will discuss who will help each role of making the documentary
    A. Recorder (person that holds recording devices)
    B. Actor: Acts out the organism
    C. Narrator: Speaks and narrates, does not need to be on camera
    D. Director (organize/guide video production)
    E. Assistant Director (helps with script)
II. Each group will be assigned an undergraduate teacher and go toward their destination
    A. Undergraduate students will be in charge of making sure their group is doing what they are supposed to be doing
        1. Undergraduate students will each carry a timer on them and ensure that students make it back to the classroom at least 5 minutes before leaving for snacks
    B. Students run the show, we will act as facilitators
        1. Undergraduates will have a sample script to help students narrate their documentary if they are unable to come up with their own

1. Script ex: Hi, my name is ____. I am here to show you our school as an ecosystem. The first thing I want to show you is ____ which is a nonliving/living thing. The organism that lives in this ecosystem is ___. It needs _____ to survive

III. After students record, they can edit, film additional pieces, narrate, add voice overs, and then present their work.

IV. It is important to note, that this curriculum carries on to the "Engineering a Solution" lesson plans. In the next series of curriculum, students will review their videos and identify a problem in the ecosystem and how they can create change and design a solution.

Unit 3: Engineering a Solution in the School Ecosystem

A Next Generation Science Standards (NGSS) curriculum for 5th graders

Authors: David Liu, Algrae Gorospe, Alondra Villegas, Vanessa Comia, Sophia Nguyen, and Steven Vu

Last edited November 2017

Big Question: How do we engineer a design to improve our school ecosystem?

Overview: Students will describe a problem they see in their ecosystems video. Then students will propose a solution and use the engineering design process to prototype, test, and improve their design solutions.

IMPORTANT: It is important to note, that this curriculum builds from the Ecosystems lesson plans. In the previous curriculum, students created video documentaries of their school as an ecosystem.

Objectives:
-Students will be able to describe a problem in their school ecosystem
-Students will be able to create a prototype of their solution that addresses their problem
-Students will be able to test their prototype and make improvements

NGSS Standards Addressed:
3–5-ETS1-1. Define a simple design problem reflecting a need or a want that includes a specified criterion for success and constraints on materials, time, or cost.
3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3–5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

Common Core Math Standards Addressed:

MP.2 Reason abstractly and quantitatively.
MP.4 Model with mathematics.
MP.5 Use appropriate tools strategically.
3-5.OA Operations and Algebraic Thinking

Common Core Literacy Standards Addressed:

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work and provide a list of sources.
W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
RI.5.1 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

Description of Lessons:

Lesson 1: Students will describe their school as an ecosystem by describing the living and nonliving things. They will use what they learned from the previous video project about their school as an ecosystem to identify the problems and possible solutions
Lesson 2: Students will describe their school as an ecosystem and describe problems in the ecosystem that prevents the living things from thriving. They will then create a timeline for their design solution, the steps necessary, and the materials needed.
Lesson 3: Students will create their solution with an initial prototype. Students will then test out their design and create changes.
Lesson 4: Students will evaluate their prototypes through testing out if the solution solves the problems. Students will then present their prototypes to important stakeholders such as teachers and administrators.

Engineering Design Cycle from NGSS

1. Define an engineering problem
2. Develop solutions to engineering problems
3. Optimize the design solution [through iterations]

Our Model of Engineering Design that Expands on NGSS

1. Ask what problems there that are can be solves with a solution
2. Imagine what solutions are possible
3. Research the feasibility, materials, and similar designs
4. Create the initial porotype
5. Test out the initial prototype
6. Evaluate the solution and modify prototype
7. Present solution to

Suggested Calendar				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Week 1 Lesson #1 Describe a problem in their school ecosystem.	Lesson #1 Brainstorm possible solutions	Lesson #2 Conduct research and find other solutions, budget etc.	Lesson #2 Continue researching	Lesson #3 Draft prototype proposal
Week 2 Lesson #3 Create prototype	Lesson #3 Create prototype and test	Lesson #3 Retest and modify	Lesson #3 Retest and modify	Lesson #3 Present to stakeholders

Lesson 1

Activity Name: Ask and Imagine

Overview: Students will describe their school as an ecosystem by describing the living and nonliving things. They will use what they learned from the previous video project about their school as an ecosystem to identify the problems and possible solutions

Goals: The goal of this lesson is for students to identify the problems within their school ecosystem. Students will begin to plan and design solutions to the problems they identify.

Materials:

- Printer Paper
- Colored pencils and markers

NGSS Standards:

3–5-ETS1-1. Define a simple design problem reflecting a need or a want that includes a specified criterion for success and constraints on materials, time, or cost.
3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

NGSS Practices:

-Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.
-Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. (3-5-ETS1-3)
-A system can be described in terms of its components and their interactions. (5-LS2-1)

Procedure

I. Class Discussion
    A. Undergraduate teacher will discuss the videos that were presented in the previous class and explain that there are problems within each ecosystem.
        1. What are some problems you (students) found in the community or in the classroom?
    B. Students will discuss as a class some problems they saw within their community, Undergraduate teacher will write the problems on the board
    C. Students will discuss possible solutions to the problems they have listed. Undergraduate teacher will write the problems on the board
        1. Narrow down problems to 5 main problems, each Undergraduate teacher will be assigned a group.

II. Brainstorm within Small Groups
    A. Students will be split into 5 groups

1. Undergraduate teacher will ensure that students discuss problems within their assigned ecosystem and begin to plan/design a solution to the problem.

Lesson 2

Activity Name: Research

Overview: Students will describe their school as an ecosystem and describe problems in the ecosystem that prevents the living things from thriving. They will then create a timeline for their design solution, the steps necessary, and the materials needed.

Goals: The goal of this lesson is for students to create a feasible solution to their ecosystem problem.

Materials:

- Printer Paper
- Colored pencils and markers
- Papers of the problems chosen from each group

NGSS Standards:

3–5-ETS1-1. Define a simple design problem reflecting a need or a want that includes a specified criterion for success and constraints on materials, time, or cost.

3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3–5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

NGSS Practices:

-Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

-Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. (3-5-ETS1-3)

-A system can be described in terms of its components and their interactions. (5-LS2-1)

Procedure

I. Class Discussion
   A. Undergraduate teacher will discuss the problems within their community that the class had chosen in the previous week
   B. Undergraduate teacher will model what the students will be doing by choosing a problem and creating a plan of action based off of one chosen solution
      1. Undergraduate teacher will introduce the first step which will be to <u>choose one solution to focus on</u>
      2. Undergraduate teacher will introduce the second step which will be to <u>create a timeline of each step in their process</u>
      3. Undergraduate teacher will introduce the third step which will be to <u>explain each step in their process and how they plan to implement each step</u>

4. Undergraduate teacher will introduce the fourth step which will be to <u>decide what materials will be necessary to implement their solution</u>

II. Brainstorm within Small Groups

A. Undergraduate teacher will be split into 5 groups

1. Undergraduate teacher will ensure that students are discussing each step of the process to plan/design/solve a solution to the problem.

Lesson 3

Activity Name: Create, Test, and Evaluate

Overview: Students will create their solution with an initial prototype. Students will then test out their design and create changes.

Goals: Students will finish planning and designing solutions to the problems they identified. Students will begin creating a prototype of their solution.

Materials:

- Printer Paper
- Colored pencils and markers
- Poster Paper
- Laptop or technology device to create a PowerPoint
- Papers of the problems chosen from each group

NGSS Standards:

3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3–5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

NGSS Practices:

-Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.
-Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. (3-5-ETS1-3)
-A system can be described in terms of its components and their interactions. (5-LS2-1)

Procedure

I. Class Discussion
   A. Undergraduate teacher will give an overview of what was done in the previous lesson. Undergraduate teacher will discuss the expectations of this lesson:
      1. Students will finish their plan of action: pros, cons, solution
      2. Students will begin to create a prototype of their solution.
      3. Next session presentations
   B. Undergraduate teacher will model what the students will be doing by using a solution and beginning to create a prototype
      1. Undergraduate teacher will introduce the solution [ex. Lunch Food, make more nutritious] through either a PowerPoint or a poster
         a) What are the materials/skills needed to create the solution?
            (1) Contact information
            (2) Budget information
            (3) Research

(4) Materials

b.) What model is being used to share the solution i.e. PowerPoint, model of invention, etc. [ex. PowerPoint]

II. Discussion with Small Groups

A. Students will be split into 5 groups from last week

1. Undergraduate teacher will ensure that students are discussing each step of the process to plan/design/solve a solution to the problem.

Lesson 4

Activity Name: Imagine, Research, Present

Overview: Students will evaluate their prototypes through testing out if the solution solves the problems. Students will then present their prototypes to important stakeholders such as teachers and administrators.

Goals: Students will present their designed solution as well as the process of designing their solution

NGSS Standards:

3–5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3–5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

NGSS Practices:

-Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.
-Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. (3-5-ETS1-3)
-A system can be described in terms of its components and their interactions. (5-LS2-1)

Materials:

- Poster board
- Colored pencils and markers

Procedure

I. Class Discussion **(15 min)**

II. Undergraduate teachers will go over the main points that each group should include in their design and remind the students that they will be presenting today.
   a. Problem
   b. Research
   c. Pros and Cons
   d. Solution

III. Undergraduate teachers will tell the class that they have 10 minutes to finalize their designs before they present
   a. Each member of the group must speak during the presentation

IV. Presentations
   a. Each group will present their designs to the class and the staff

APPENDIX B
Research Instruments and Protocols

Protocol 1: Identity Survey

Dear Student,

We want to learn about what makes you interested or not in science, and your experiences in both science classes and in after-school programs.

As part of this project, we would like you to complete this survey. The survey takes about 20-30 minutes. Please read each question and mark the best answer for you. Let us know if you have any questions. We are happy to help.

Thank you for your help.

NAME	________________________________
Your **GENDER**	☐ Female ☐ Male

[BACKGROUND] Check all that apply. You can check more than one.

- White/Caucasian/European/European American
- African American/Black African
- Latino/Hispanic (Puerto Rican, Mexican, South American, etc.)
- Asian/Asian American/Pacific Islander American (Arab, Indian, Chinese, etc.)
- Hawaiian/Native Hawaiian
- American Indian/Alaska Native
- Other (please specify): ________________

Q1. Please indicate how much you agree or disagree with the following statements about you. (Mark one in each row).

	Disagree Strongly	Disagree Somewhat	Agree Somewhat	Agree Strongly
I think science is interesting.	☐	☐	☐	☐
Science is important to me.	☐	☐	☐	☐
I am good at science.	☐	☐	☐	☐
I think I could be a good scientist.	☐	☐	☐	☐
I use science to solve problems in everyday life.	☐	☐	☐	☐
I enjoy learning in science class.	☐	☐	☐	☐
What I learn in science class may be useful to my future.	☐	☐	☐	☐
It is important to me that I get a good grade in science class.	☐	☐	☐	☐
I feel that I know as much about science as other students do.	☐	☐	☐	☐
I enjoy going to science lessons.	☐	☐	☐	☐
Science is one of the most interesting school subjects.	☐	☐	☐	☐

Please continue on the next page.

Q2. Please indicate how much you agree or disagree with the following statements about science in general: (Mark one in each row)

	Disagree Strongly	Disagree Somewhat	Agree Somewhat	Agree Strongly
Scientists have a chance to make a difference in the world.	☐	☐	☐	☐
Science helps people.	☐	☐	☐	☐
Scientists have to work hard.	☐	☐	☐	☐
There are a lot of jobs available in science.	☐	☐	☐	☐
Scientists make a lot of money compared to non-scientists.	☐	☐	☐	☐
Science is a respected and valued career.	☐	☐	☐	☐
Spending money on science is important to all of us.	☐	☐	☐	☐
Scientists enjoy spending time with their families.	☐	☐	☐	☐

Q3. Do you do any of the following activities at HOME? (Mark one in each row)

	I did this a month ago	I did this in the last 6 months	I did this last year	I have never done this
Read books about science or science fiction.	☐	☐	☐	☐
Take care of an animal or plants.	☐	☐	☐	☐
Talk with family about science.	☐	☐	☐	☐
Look up science information in the library or on the internet.	☐	☐	☐	☐
Use special science equipment (telescope, microscope, chemistry set, etc.).	☐	☐	☐	☐
Make models (airplane, dinosaur, house, etc.) or build things using tools.	☐	☐	☐	☐
Collect rocks, butterflies, bugs or other things in nature.	☐	☐	☐	☐
Take apart things (like motors, computers, toasters, etc.) to see how they work.	☐	☐	☐	☐

Please continue on the other side of this page..

Q4. Can you connect to the Internet at home? (Mark all that apply)

Yes, by my computer
Yes, by my phone or tablet
No

Q5. Who do you live with most of the time?

	Yes	No
Mother or stepmother	☐	☐
Father or stepfather	☐	☐
Brother(s) or sister(s)	☐	☐
Other adult (a legal guardian, grandparent, aunt, uncle)	☐	☐

Q6. Who living with you at home has attended or is attending college? (Mark one in each row)

	Yes	No	I'm not sure
Mother or stepmother	☐	☐	☐
Father or stepfather	☐	☐	☐
Brother(s) or sister(s)	☐	☐	☐
Other adult (a legal guardian, grandparent, aunt, uncle)	☐	☐	☐

Q7. Of the following people, who has a science-related job? (Mark one in each row)

	Yes	No	I'm not sure
Mother or stepmother	☐	☐	☐
Father or stepfather	☐	☐	☐
Brother(s) or sister(s)	☐	☐	☐
Other adult (a legal guardian, grandparent, aunt, uncle)	☐	☐	☐

What is your Mother or stepmother's job? ______________________

What is your Father or stepfather's job? ______________________

What is your Brother(s) or sister(s) job? ______________________

You are half way finished! Please continue on the next page.

Q8. Please indicate how much you agree or disagree with the following statements about your family/legal guardians: (Mark one in each row)

	Disagree Strongly	Disagree Somewhat	Agree Somewhat	Agree Strongly
They think it is important for me to learn science.	☐	☐	☐	☐
They are interested in science.	☐	☐	☐	☐
They would be happy if I pursued a career in science.	☐	☐	☐	☐
They would support me if I pursued a career in science.	☐	☐	☐	☐

Q9. What is your BEST guess as to your OVERALL grades this year (for all of your classes)? (Mark one)

- Mostly As
- Mostly As & Bs
- Mostly Bs
- Mostly Bs & Cs
- Mostly Cs
- Mostly below Cs

Q10. What is your BEST guess as to your current grade in SCIENCE class this year?

- A
- B
- C
- Below C

Q11. How much do you want to go to college?

- A lot
- Somewhat
- A little
- Not at all
- I don't know

Please continue on the other side of this page

Q12. For your SCIENCE CLASS this year, how often to you: (Mark one in each row)

	Never	Sometimes	Most of the time	Always
Participate in class discussions	☐	☐	☐	☐
Work on assignments with other students	☐	☐	☐	☐
Discuss how science applies to real life	☐	☐	☐	☐
Do the classwork in class	☐	☐	☐	☐
Ask questions in class	☐	☐	☐	☐
Do work for extra credit	☐	☐	☐	☐

Q13. Have you done any of the following outside activities in THIS SCHOOL YEAR NOT for your science class? (Mark one in each row)

	I did this a month ago	I did this in the last 6 months	I did this last year	I have never done this
Attend a science camp or special program	☐	☐	☐	☐
Participated in a science fair	☐	☐	☐	☐
Participated in a science club or team	☐	☐	☐	☐
Worked on a real-life science project or experiment	☐	☐	☐	☐
Visited a science museum	☐	☐	☐	☐
Spent time outside learning about nature	☐	☐	☐	☐

Please continue on the next page.

Q14. Please select all applicable answers.

	Teacher	Friends	Parents/legal guardians	Other people	None of the Above
I have heard that I am good at science from	☐	☐	☐	☐	☐
I have had my science work praised by	☐	☐	☐	☐	☐
I have been asked to help with a science-related problem by	☐	☐	☐	☐	☐

Q15. Please indicate whether you have had the following experiences by marking either yes or no.

	Yes	No
I have received awards or special recognition for my science-related activities	☐	☐
I have presented a project in science to others (science fair, after-school science project)	☐	☐
I have been told by others that I am a good scientist or good science student	☐	☐

Q16. Please indicate how much you agree or disagree with the following statements about science in general: (Mark one in each row)

	Disagree strongly	Disagree somewhat	Agree somewhat	Agree strongly
I am interested in participating in science-related activities in the future, such as environmental campaigns, science days in my community, health fairs, etc.	☐	☐	☐	☐
Knowing science will be important when I make big decisions for my future, such as my health, children, home, etc.	☐	☐	☐	☐
I would like to teach science when I finish school.	☐	☐	☐	☐
A career that involves science-related work would be interesting	☐	☐	☐	☐

Please continue on the other side of this page.

Q17. How interested are YOU in having a job like these someday? (Mark one in each row)

	Not at all interested	Not very interested	Somewhat interested	Very interested
Life scientist (Biologist, Zoologist, etc.)	☐	☐	☐	☐
Physical scientist (Chemist, Physicist, Astronomer, Forensic Scientist, etc.)	☐	☐	☐	☐
Environmental Scientist (Geologist, Climatologist, Ecologist, etc.)	☐	☐	☐	☐
Engineer	☐	☐	☐	☐
Architect	☐	☐	☐	☐
Computer programmer or Website Designer	☐	☐	☐	☐
Doctor, Veterinarian, Dentist	☐	☐	☐	☐
Dietician or health related job	☐	☐	☐	☐
Psychologist, psychotherapist	☐	☐	☐	☐

Q18. If you are very interested in any of the jobs listed above, about how old were you when you first became interested in them? (Mark one)

- Younger than 5 years old
- 5 – 7-year-old
- 8 – 10 years old
- I’m not very interested in any of the jobs above

Protocol 2: Observation Protocol

Date, Location, and Time:
Participants:
Abstract

Observations
How does the teacher start the class?
bring the class to order?
review previous lesson?
introduce the new lesson?
Where are the case study girls sitting?
Who is the sitting near?
What are they doing as the teacher brings the class to order and introduces the new lesson?
What does the teacher do?
What do the students do?
What are the main activities & tasks that occurred?
If any questions or ideas come up as you are taking the notes put them in the reflective comments section.
Features of the setting (curricular context, tasks, norms, rules, expectation)
Assumed roles and positioning
Recognition and class response
Changes in discourse
Resources leveraged
Identity artifacts
Learning outcomes

Reflections
What were the main ideas being taught?
What were the activities & tasks?
What approach did the teacher take?

Summary/Memo
Case study students' Participation
How does the teacher create opportunities for the case study girls to participate? Describe an event (if possible) that captures such an opportunity? What were the pedagogical strategies?
How does the girl(s) participate in the class? What did the girl(s) say or do? How was it taken up by the teacher or the class?
Describe an event where one (or more) of the case study girls say or does something interesting. What happened in this event? What did the teacher do? What did the student do?
Pedagogy
Describe the pedagogical style of the teacher?
What strategies does the teacher rely on?

Protocol 3: Student Interview

The purpose of this interview is to understand how students identify current and future self in science across multiple figured worlds. The interview will be focused on hearing their stories of self and science along the specific context.

Background Questions
Can you introduce yourself to me?
How do you get to school? Who is taking you to school?
What do you do at home?
Can you describe your community?
What do your parents do? Who lives at home with you?
Do you live with any siblings? Are they in school? What do they do?
What do you do after school and on the weekends?
Anyone who does science in your families?

[Current self]
[self-conception] List five words that describe science to you. Explain why you picked those words.
[self-conception] List five words that describe you in science. Explain why you picked those words.
[School related figured world] Tell me a story about something that happened in your class this year or last year that made science more interesting to you (if applicable). Explain. [Following questions] [If students pick stories from last year] is there anything interesting happens this year? What was the main task? What did you do? Who else were there? Why do you think it made science less interesting to you?
[School related figured world] Tell me a story about something that happened in science class this year and last year that made science less interesting (if applicable). Explain. [Following questions] What was the main task? What did you do? Who else were there? Why do you think it made science less interesting to you?
[Out of School figured world] Tell me a story about something that happened outside of science class that made science more interesting to you. [It could be something like a field trip, after school club, something you did on the weekend] Explain. [Following questions] What was the main task? What did you do? Who else were there? Why do you think it made science less interesting to you?
[Out of School figured world] Tell me a story about something that happened outside of science class that made science less interesting to you. [It could be something like a field trip, after school club, something you did on the weekend] Explain. [Following questions] What was the main task? What did you do? Who else were there? Why do you think it made science less interesting to you?
[self-esteem at school related figured world/perception about good students] How would you rank yourself on a score of 1-4 of how good you are in science. Why did you pick that number? Who would rank a 4 in the 5th grade class and why?

Do you think your science class gives you a good "look" into what "real" science is like? Why or why not.
Can you think about any moment when you feel like you are doing "real" science? When, where, and what did you do? What do you think made you think so? Where else do you get your information (examples: a parent who is a nurse or a chemist, CSI, Bill Nye, books, etc.)
[Family related figured world] Tell me a story about when you used science at home. What did you do? How did you use science?
[Informal setting: Science club] You have participated in science club throughout last year. What made you participate in the club in the first place?
Can you tell me about YOUR experience of this club this year?
What would you like to add or change to the science club? Why?

[Future self]
What kinds of jobs or careers might you want to have in the future?
What kind of classes do you want to take when you start in middle school and high school?
Is there any change in your thoughts about your job from last year? If so, what make you change your mind? Is there any incident, people, or any experience that you think has any influence on the change of your mind?
Does learning science matter for this job? If so, how?
Do you plan to go to college or community college? If yes, what will you study in college? If not, why did you make that choice? What do you plan to do after high school?
Draw a picture of yourself in science class

Protocol 4: Teacher Interview

Background Information

Could you introduce yourself to me?
Do you enjoy teaching science?
What got you into teaching?
Can you describe your educational background?
What is your teaching experience?
What is your background in science?
How do you teach and what is your teaching philosophy? (student centered, reform-oriented vs. traditional, didactic, transmitting knowledge).

Teaching Science in the Classroom

[Classroom] Could you introduce your classroom? How would you characterize your classroom? Is there any unique feature that you would like to highlight?
How do you usually organize your class? What about science class? How do you decide science activities?
What are you trying to accomplish through science class?
What are the major challenges in running science?
What are the major successes in running science?
What is your goal as the 4th and 5th grade combo science teacher? Are the two grades different?

Teaching Science and After School Club

[Science club] Could you introduce your club? How would you characterize your club? Is there any unique feature that you would like to highlight? Why did you start this club? What kind of students come?
How did you recruit the students? Are there any students who stands out to you when you recruit students?
How do you usually organize your club activities? How do you decide club activities?
What are you trying to accomplish through this club or club activities?
What are the major challenges in running the club?
What is your goal as teacher running the after-school club in general? What about a science teacher running the club?
Do you see any difference in yourself between when you run the club and when you teach science?

About Case Study Students

[General description] Could you briefly introduce the students in your class? Can you share with us your general impression of X? [prompt: Is she a good student in general, is she a good science student, is she one of the target students you would direct a science question to, what is the quality of her work, her grade, etc.]

[Funds of knowledge] What is the strength of each student?
What do they like, are they interested in?

Do you think they like science? What grades (1,2,3,4) would/did you give them? Why?
Would you say that X is an active participant in science? [prompt: Does she participate all the time? Is she enthusiastic in science – how does she show her enthusiasm? Does she volunteer in science to help you out (pass materials, put up posters, care for classroom pets, etc.)
What kinds of science activities does X seem to be most engaged with? [e.g. small group activities, hands-on activities, or individual research, etc.]
During this content area, how do you think the case-study students participated? Were you pleased with their participation, did their participation fulfill or exceed your expectations for this unit? In what ways?
[Challenges] Particular challenges do you think that face X
[Career aspiration] What the students' career plans are? Out of these case study students that you teach, who do you think, as their science teacher, has the strongest potential to pursue a long-term science trajectory (if you can say?) why? - [don't know if this is a good question but potentially interesting]
[Figured worlds] Are they participating in any other club, activities?
Is there any event relating to science in this school? Any science fair or project?
Who do they usually spend time with during lunch or recess?

School/community (informal)
Is there any unique characteristic or feature of your school or communities that you think we need to know to understand the context of this club?
How would you like to describe the parents or communities? How about the students' family?
What will the transition for them be like next year when they move to 6th grade? What kind of classes do they offer?
Is there anything that you would like to try in your science class in the future?

Protocol 5: Home Log

Thursday: Record or take pictures of what you typically do when you come home from school. Where do you see science when you go home?

Friday: What are some of your favorite games and things to do at home? Who do you play with? Is there science involved? And if so, how?

Saturday: Who did you spend today with? Show through photos or video. Introduce your Extended Day project to them. What was their reaction?

Sunday: What kind of activities do you with your family on the weekends? Is there any science involved?

Monday: Please record or take a picture of something you think makes you unique. How does this make you unique?

Tuesday: Take a picture of something you ate today.

Wednesday: Be sure to bring the iPad back to your UCI team member on Thursday. Final challenge: Record a video or take a picture of something at home that shows how proud you are of your family. Why are you proud?