ENTREPRENEURIAL TEACHING IN CREATING THIRD SPACES FOR EXPERIENTIAL LEARNING: A CASE STUDY OF TWO SCIENCE TEACHERS IN LOW-INCOME SETTINGS

BY

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DISSERTATION

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Abstract

This three-year study focuses on two high school science teachers who created active learning opportunities that invite students to go beyond the textbooks and did so within low-income settings. The first case centered on Faith Cumberland, a teacher who created summer science camps and science road shows for elementary-age students. Partnering with high school students to lead and mentor younger students, Faith built opportunities for elementary-age students to experience science through experiential, reform-minded science activities designed around scientific topics such as forensics, physics, engineering, chemistry, and contemporary topics such as nanotechnology. Working with local community centers, Faith brought science experiences into the community as well as provided part-time summer employment for her students. The second case focused on David Dressler, a teacher who developed after-school opportunities for students to apply physics to real-world environmental and societal issues. Working within three different low-income, urban schools, David developed a school beautification project and used solar panels and biodiesel to bring electricity to a Haitian school. This second case investigated the project-based, experiential science curriculum David used in school and after-school clubs. With both cases, the animation of marginalized youth in social action through science is explored through an entrepreneurial lens. David and Faith established new spaces for science learning to occur and gained financial support through external resources. They animated students, teachers, and community members and invited them to take an active role in shaping the projects, and they acknowledged them publicly. They fostered enough community support for their projects to be ongoing. These teachers’ entrepreneurial actions created third spaces beyond existing school structures, providing students with learning opportunities to experience science.
To My Loving and Supportive Family
### Table of Contents

Chapter 1: Introduction ........................................................................................................... 1  
Introduction to the Concept of Educational Entrepreneurship ............................................. 1  
Statement of the Problem: Science Education in Low-income Contexts ............................... 3  
Creating a Third Space for Learning ................................................................................. 5  
Overview of Teachers as Entrepreneurs ........................................................................... 6  
Purpose and Research Questions ...................................................................................... 8  
Breaking From Prior Educational Entrepreneurship Literature ......................................... 8  

Chapter 2: Literature Review ................................................................................................. 10  
Introduction ....................................................................................................................... 10  
A Brief Background on Entrepreneurship From an Economic and Business Perspective .... 11  
Entrepreneurship Across Different Domains ..................................................................... 12  
Connection Between Entrepreneurship and Education ...................................................... 14  
Impact of Institutional Structure and Culture of Schooling on Entrepreneurial Activity .... 22  
Experiential Learning and Reform-Minded Science Teaching .......................................... 30  
Rise of Informal Learning to Give Students Active Experiences ........................................ 34  
Creation of Third Spaces for Innovative Learning .............................................................. 35  
Opportunity for Research in Educational Entrepreneurship ............................................. 36  
Shifting Research Focus From Competencies of Entrepreneur to Entrepreneurial Activity ... 38  

Chapter 3: Methods ............................................................................................................... 43  
Introduction ....................................................................................................................... 43  
Background of the Study and Purposeful Selection ............................................................ 45  
Faith’s Case ......................................................................................................................... 48  
Faith’s Data Sources and Contexts ..................................................................................... 48  
David’s Case ....................................................................................................................... 52  
David’s Data Sources and Contexts .................................................................................... 52  
Data Analysis ...................................................................................................................... 53  
Establishing Trustworthiness ............................................................................................. 56  
Conceptualizing the Cases ................................................................................................. 61  
Roles of the Researcher ....................................................................................................... 65  

Chapter 4: Creating Spaces for Science Discovery ............................................................... 68  
Introduction to Chapters Four and Five ............................................................................. 68  
School Science Learning Beyond the Classroom: Building Science Summer Camps ........ 68  
Experiential Learning Across Settings: Seeing, Tasting, Hearing, and Feeling Science ....... 86  
Experiential Learning in Class: Giving Space for Open Exploration and Student Leadership 93  
Science Learning on the Road: Making Learning Science Active in the Elementary Schools 105  
Support for School Science Beyond the Classroom: Collaborating with School, Community, University, and Individual Sponsors ................................................................. 115  
Structure of Schooling: Constraining Nature of Bureaucracy, Structures, and Curriculum... 120
Chapter 5: Using Science to Solve Real-World Problems

Connecting Science Beyond the Classroom: Biodiesel, Electricity, and Beautification After-School Projects
The Settings of Three Low-Income, Urban High Schools
Failing at, Tinkering With, and Teaching Science: David’s Background and Sense of Care
Experiential Learning During Class: Practical Applications and Future Preparations
Experiential Learning Before and After School: Reinforcing School Science
Experiential Learning: The Importance of Outside Experiences With Science
Navigating the Structures and Expectations of Schools to Achieve Results

Chapter 6: Discussion and Implications

Introduction
Third Spaces as Places to Connect Educational Science With Community
Entrepreneurial Action for Experiential Learning
The Nature of Support and Grit to Persevere in Creating New Learning Opportunities
Insight Into Entrepreneurial Teaching
Implications

References

Appendix A: EnLiST Grant Description
Appendix B: Entrepreneurial Spirit and Leadership in Education Interview Conversation Protocol
Appendix C: Interviews and Observation Schedules
Appendix D: Overview of Participant Schools
Appendix E: Sample Contact Summary Sheet
Appendix F: Sample Field Notes Based on Conversation During Field Observation
Appendix G: Sample Memo Based on Data
Appendix H: Fat Data Session Notes
Appendix I: Sample Interim Report
Chapter 1: Introduction

Introduction to the Concept of Educational Entrepreneurship

We have seen that the function of entrepreneurs is to reform or revolutionize the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way, by opening up a new source of supply of materials or a new outlet for products, by reorganizing an industry and so on. (Schumpeter, 1942, 2011)

The economist Schumpeter (1942, 2011) argued that the role of the entrepreneur was to repurpose or create new ways of supplying or producing materials and/or services that change how we engage with the world around us. Often, entrepreneurs are thought of only in terms of those who develop new businesses or create new products in the commercialized marketplace. These individuals are featured in magazines such as Fast Company or Entrepreneur and appear on the front page of the Wall Street Journal. The concept of entrepreneur, however, is not limited to the commercial industry. Drucker (1985), a management theorist, explains that entrepreneurship can be applied to all activities of human beings and extends across many different fields, including education.

When looking for educators who have been recognized for their entrepreneurial endeavors, Madhu Viswanathan, a professor of business administration at University of Illinois, Urbana-Champaign (UIUC) serves as a compelling example. Viswanathan is the founder and director of Marketplace Literacy Project, a nonprofit organization with the mission of providing educational services to people living in poverty in the city of Chennai, India. As part of the Marketplace Literacy Project, Viswanathan and his collaborators provide learning spaces for women to gather and learn marketplace literacy skills. Through these learning opportunities, the women acquire marketplace navigation skills, develop consumer literacy, practice being wise consumers, and better manage their limited finances. To do this, the Marketplace Literacy
Project attempts to break marketplace barriers between individuals and groups and increase the level of interaction of attendees who are typically separated by caste and socioeconomic status (Viswanathan, Gajendiran, & Vaenkatesan, 2008).

In addition to the creation of the Marketplace Literacy Project, Viswanathan, through his role as a professor, provides unique learning opportunities for his university students that go well beyond the university classroom and into impoverished areas of India. Through social outreach and his business expertise, Viswanathan designed a college course for both graduates and undergraduates. Within this course, students complete a poverty simulation, learn about marketplaces, draft product concepts that students feel will be relevant to the needs of those most in need, and travel to the most impoverished areas of India to gain more awareness. During the 10-day journey, “sometimes, a consumer product will morph into a tool for a microbusiness. For example, a team retargeted its idea for solar ovens from households to mobile tea carts and food carts” (Buchanan, 2011).

By creating new educational spaces that join the academic world with an area experiencing significant marketplace literacy needs, Viswanathan hopes to provide necessary skills to improve the lives of those living in poverty. He has generated enough support to create these unique learning opportunities, and his course was recognized as the Best Entrepreneurship Course in 2011 in Inc. magazine. Viswanathan provides an example of an entrepreneurial educator who has a focus on social issues such as low literacy, he demonstrates how entrepreneurship connects with the domain of education, and his work illustrates the role entrepreneurship can play in providing educational opportunities in low-income, resource-lean contexts. This idea that educators can serve as entrepreneurs has not received much attention in
the literature, and I was motivated to look at educators in public school settings who may be creating new spaces for learning.

**Statement of the Problem: Science Education in Low-income Contexts**

Entrepreneurs identify needs within a given context and then build ideas, solutions, and actions to address the needs. It may be argued that there are many needs within the realm of American public education. For this research, the focus was on science. In 2006, the Programme for International Assessment (PISA) released a large-scale international study of 15-year-olds’ academic performance and included science performance as well as student attitudes toward science. While over 90% of students recognized the importance of science and the advances that have been made, only 57% said that science was relevant to them personally, and only 37% said they would like to work in a career involving science (p. 26–28). Although interest does not necessarily correlate with high performance in science, “interest is an important predictor of high-performing students’ choice of a science related career” (Drechsel et al., 2011, p. 78). Increasing student interest and engagement in science has significant implications when students who have an ability to excel in science and engineering choose other fields they find more compelling and relevant.

Low-income settings offer additional challenges in relation to student interest in the subject of science as well as limited student access to advanced science courses. Basu and Barton (2005), focusing on low-income, urban settings state, “Indeed, the rhetoric surrounding science education in low-income urban communities in particular is that students do not like science because it is not connected to their interests or experiences” (p. 466). In low-income settings in Illinois, students’ access to advanced courses in sciences remains significantly lower (Rado & Malone, 2011). When it comes to science, the issues of urban, low-income settings are
similar to the issues in small-city, low-income settings. These issues include outdated textbooks and lab equipment, lack of qualified teachers, limited field trips and outside experiences that increase the relevance of science, and a lack of breadth of science courses that go beyond basic knowledge (Barton, 1998).

The bridge between the fields of science and engineering and a nation’s economic vitality has been clearly established. Operating with the backdrop of an ongoing economic crisis that began in 2008 and which has severely limited funding for public education, those educational programs that go beyond the standard curriculum and provide hands-on, relevant learning experiences are being sacrificed in the name of budgetary constraints. When the requirements of No Child Left Behind (NCLB) and the subsequent Race to the Top programs that tie school funding to performance on high-stake tests are added in, those courses considered to be essential for performance on these tests take precedence over any courses that are geared to hands-on learning and increasing student interest and engagement in experiential content learning. When it comes to science education at the secondary level, students are only exposed to courses that align with the standard curriculum with few, if any, options to go deeper into the fields of science prior to graduating high school. The ability of a field to attract and retain talented people relies heavily on its ability to demonstrate its value, meaning, and relevance to a person’s life. Limiting student experience to only knowledge acquisition stunts the ability for students to explore and see the value of the content in real-world settings.

The study of science within the classroom, or what I will call school science, is often confined to facts and application of knowledge and formulas. With school science, issues of relevance and impact are absent, and school science fails to address practical implications and the creativity of science.
For example, science is often presented as a very technical field that has been stripped of all human elements and is practiced by super intellectuals. Work in school science laboratories is often individualistic and competitive; students follow defined procedure and strive to carry out experiments that prove an already known fact. Projects are often not relevant to students’ lives. Students may question why they are doing the activity, and what its utility for humankind might be. Procedures are often rigid and leave no room for messy data, creativity or the expression of personal strengths (Cunningham & Helms, 1998, p. 487).

The gap between low-income youth and their access to and interest in science provides significant issues. One issue is students do not see the value of science within their own lives. In addition, there is a need to increase the diversity of students choosing to find their way into the science and engineering pipeline; however, diverse students are not seeing science as a viable academic path after high school. Cunningham and Helms (1998) offer a solution that may close the gap between science and marginalized students. “By acknowledging or infusing characteristics of real science that are currently often absent from the science classroom, science may become more attractive to marginalized students; it can expose the human face (and the messiness) and remove the sterile façade” (p. 487). The question becomes how do teachers accomplish this goal, and is it possible given the context of schooling in the United States.

Creating a Third Space for Learning

Emdin (2009, 2011) has conducted studies on the estrangement of low-income youth from science and recommends opportunities that transcend the current classroom structure in order to engage youth in more real-world science. These spaces that provide students the ability to see and experience academic knowledge interacting and intersecting with life beyond the
institution of school has been called a third space, and it is these third spaces that some argue are the way to increase student engagement in particular content areas (Emdin, 2009; Moje, et al., 2004; Guitierrez, 1999). The teachers and schools who dedicate time and energy to making new learning opportunities for students in low-income contexts are not giving in to the difficult conditions, but rather are finding new ways to make science relevant and important to the lives of their students through the creation of new spaces for learning. Just as Viswanathan created new spaces for learning marketplace literacy in Chennai, India, these teachers are creating new spaces for students to learn science.

It is impossible to ignore that teachers operating in areas of great economic difficulty are faced with particular challenges if they desire to create a third space that provides hands-on science learning experiences that go beyond the prescriptive curriculum. Teachers lack the financial support, the facilities, and the resources to create innovative learning experiences. Those teachers who hope to bring additional innovative science learning to their students and schools must be resourceful in obtaining financial resources. Even with the constraints of school budgets, there are teachers who have successfully created additional spaces for learning science. However, there is limited research that focuses on how teachers establish these new spaces. This study aimed to investigate two teachers who created science learning opportunities that engaged students in science beyond school structures, connected students to their communities through science, and accomplished this in low-income high schools.

**Overview of Teachers as Entrepreneurs**

Entrepreneurs, and in particular, social entrepreneurs, are change agents who seek out innovative solutions to problems, identify resources, and develop initiatives to address social issues (Brouard & Larivet, 2010; Dees, 2007; Dacin, Dacin, & Matear, 2010). Social
entrepreneurs share similar qualities and behaviors to business entrepreneurs; however, they are more driven by the desire to help and impact others’ lives than by a desire to turn a profit (Thompson, 2002). Creating social value or bringing about social change is an important distinction between social entrepreneurship and forms of entrepreneurship focused on competitive advantage and financial gain. Chand and Misra (2009) connect social entrepreneurship to innovative teachers creating ideas that address social issues and call these teachers “edupreneurs.”

Abd-El-Khalick, Gaffney, et al. (2011) defined entrepreneurial teacher leaders with a specific focus on science, technology, engineering, and math (STEM): “Working in contexts that are (or justifiably perceived to be) resource-deprived, entrepreneurial STEM teachers succeed in creating innovative and transformative learning opportunities or environments, both within and beyond their own classrooms, such that the quality and quantity of students’ STEM learning experiences and outcomes are markedly better than the actual or perceived norms of their milieu.”

Blending the prior research on entrepreneurial teachers with Brouard and Larivet’s (2010) social entrepreneurship conceptualizations, I developed the following definition for entrepreneurial teachers:

*Teachers who use content knowledge and expertise to develop innovative educational opportunities that students value and seek out, and who build connections between the school, the community, and/or society.*

Research focused on academic entrepreneurship provides a pathway for conducting research in teacher entrepreneurship, and this study built upon the work of Bresler (2009) and her research on academic entrepreneurs. Academic entrepreneurs share several characteristics
including (a) using imagination and creativity in envisioning exciting new projects and creating educational opportunities; (b) being engaged in a process of experiential learning that involves learning from mistakes, listening to their students, and learning from them in a process of team leading rather than assuming an authoritarian, prescriptive role; (c) working across units, often beyond institutional boundaries; and (d) adopting a collaborative style that includes promoting ownership in the project and acknowledging others. These characteristics of academic entrepreneurship provide an underpinning for looking more closely at entrepreneurial teachers who have created new spaces for academic learning. It is this prior research in social and academic/intellectual entrepreneurship that served as the basis for this research on two science teachers and the operational curriculum of the regular school day and after school.

**Purpose and Research Questions**

This study investigated two science teachers who created learning opportunities for students that went beyond their classrooms and who were operating within low-income contexts. Using these two cases, the major research questions for this study were these:

1. What approaches did these teachers use to create new science learning opportunities for their students?
2. What type of science learning opportunities did these teachers create within and beyond their classrooms?
3. What sustained these teachers to pursue these activities? What forces did these teachers encounter that supported or impeded these activities?

**Breaking From Prior Educational Entrepreneurship Literature**

To date, much of the educational entrepreneurship literature centers on external organizations reforming education, such as charter schools, textbook companies, and alternative
certificate programs (Hess, 2006; Hess, 2008; Sandler, 2010). This type of educational entrepreneurship has been labeled venture philanthropy by Saltman (2012) and has been critiqued as the corporatization of public schooling and a neoliberal assault on public education. Examples within this body of educational entrepreneurship literature focus on funding by external organizations to transform education and create a competitive system of schools. This type of educational entrepreneurship is not the focus of this study. Venture philanthropy and educational entrepreneurship defined by Hess has a focus on external organizations operating as funders of educational initiatives that break from the system. Rather, this study is rooted in social entrepreneurship and focuses on teachers who are engaged in creating new spaces for learning through the use of entrepreneurial action. The teachers in this study were not driven by profit motives or by competing with others; rather, their emphasis was on building new opportunities for students to experience science.
Chapter 2: Literature Review

Introduction

In this case study research, the emphasis was on two teachers who created learning opportunities for students beyond their classrooms and the actions they took to create these opportunities. Faith and David were selected because they built experiences for students beyond the school day, and their actions connected with prior research and scholarship around entrepreneurial behaviors and academic entrepreneurship. The review of the literature for this study began with the field of entrepreneurship and, more specifically, entrepreneurial action tied to education, schools, and teachers. This chapter provides a discussion of the literature review that was conducted throughout the course of the study. The review of literature started before the participants were selected, continued during data collection and analysis, and extended into the final writing stages of the dissertation. As the findings for the study emerged, the literature review developed and included issues found within the cases, including third spaces and experiential learning. The major sections for this chapter include (a) brief background on entrepreneurship from an economic and business perspective; (b) entrepreneurship across different domains; (c) connection between entrepreneurship and education; (d) difficulty of teachers’ entrepreneurial endeavors within the context and cultures of schools; (e) incorporating experiential education within and beyond schools; (f) creation of third spaces for experiential education; and (g) research opportunities focused on entrepreneurial action and education.

Literature review process. The review of entrepreneurial literature started during a course focused on social and academic entrepreneurship taught by Dr. Liora Bresler at UIUC. To continue with the literature review, I conducted searches through several databases available at UIUC, including Academic Search Premier (EBSCO), Academic Onefile (Gale), Periodical
Abstracts (OCLC), Scopus Database (Elsevier), and the Web of Science. In addition, the search results returned books from a variety of sources (libraries and online bookstores). I also reviewed popular, nonscholarly news websites and magazines such as *Fast Company* and *Entrepreneur*.

**A Brief Background on Entrepreneurship From an Economic and Business Perspective**

The economist Schumpeter (1942/2011) created the seminal work *Capitalism, Socialism, and Democracy*, an exploration of economics, progress, government, and socialism. His book serves as a foundational work when it comes to entrepreneurship. Within this work, Schumpeter describes the nature of entrepreneurship and the entrepreneur. Schumpeter distinguishes an entrepreneur from an “office worker” (p. 133). The office worker, Schumpeter explains, is content to move through the motions of work, but an entrepreneur is compelled to challenge the status quo in new and innovative ways. Schumpeter provides a variety of examples from a small revolution, such as developing a new toothbrush, to the more radical revolution, such as the construction of the railroads. Regardless, Schumpeter’s entrepreneur moves beyond routine tasks and challenges the system and others to adopt a new approach, product, or service. This challenge to others often comes at a price for the entrepreneur. As Schumpeter explains, the environment may refuse to accept the new product or service and the departure from the accepted social standards. This move from the status quo may even result in the entrepreneur facing “physical attack” (p. 132). The power of the routine means that someone who operates outside of this routine faces ridicule, may struggle to get a new approach financed, and may be the target of attempts to silence or move the person back into the routine order of things. Even when faced with such difficulties, Schumpeter argues, the entrepreneur pushes on: “To act with confidence beyond the range of familiar beacons and to overcome that resistance requires
aptitudes that are present in only a small fraction of the population and that define the entrepreneurial type as well as the entrepreneurial function” (p. 132). For Schumpeter, being an entrepreneur is rare. An entrepreneur must couple an innovative vision that revolutionizes a product or system with the resilience to overcome the inherent barriers associated with changing the environment. The benefits of having entrepreneurs within a society, Schumpeter points out, is that they create new products and services that create opportunities for new employment and business, and these opportunities are healthy contributors to building a stronger economy. Although the resistance an entrepreneur faces is strong, the benefits are vital for progress.

Drucker (1985), who has been recognized as being a significant voice in the study of management and business, also sees entrepreneurs as people who break free and move forward with a change. He explains that entrepreneurs see changes as normal and part of how the world works, they see these changes as healthy, and they often look for opportunities to create value through change (p. 27). Drucker states, “Usually, they (entrepreneurs), do not bring about the changes themselves. But—and this defines entrepreneur and entrepreneurship—the entrepreneur always searches for change, responds to it, and exploits it as an opportunity” (p. 28).

Entrepreneurs acknowledge the changes that are underway, recognize how these changes may be used to break away from established structures and systems, and capitalize on those changes to create value for those around them. Much of the entrepreneurship literature remains rooted in economics and business; however, scholarly literature focused on entrepreneurship has been appearing in different domains.

**Entrepreneurship Across Different Domains**

While the history of entrepreneurship is connected to business and economics, the concept has spread to different domains, including social, cultural, academic, and educational.
The different domains of entrepreneurship literature provided insight into the concept of entrepreneurship and entrepreneurial behaviors targeted at different aims and applied within different settings. In Figure 2.1, I provide a brief overview of the differing domains as well as scholars whose work is included within each. The figure provides a categorizing of the different domains of entrepreneurial literature reviewed, and the image of water flowing behind the different domains is intended to show that these domains are not exclusive of one another as there is overlap between and among the different domains.

![Figure 2.1](image.png)

*Figure 2.1. The different domains of entrepreneurship literature explored as part of the literature review.*
Connection Between Entrepreneurship and Education

Entrepreneurship as an area of study has broadened to include various contexts, and this includes education. The purposes and background from the different domains of entrepreneurship provide a perspective as to why education lends itself to entrepreneurship. While much of the literature around entrepreneurship in K–12 schools has focused on the creation of private enterprises aimed at reforming education, there have also been empirical studies focused on the entrepreneurial efforts of educators. For the purposes of this section of the literature review, I include research on educators in higher education as well as research on K–12 schools. The educational entrepreneurship literature, when considered along with the entrepreneurship literature across the different domains, provides common behaviors of those who take entrepreneurial action.

Entrepreneurial action and connection to teaching. Entrepreneur, entrepreneurship, and entrepreneurial are social constructs. As a result, varying perspectives and definitions have been offered for these terms. As social constructions, the terms are not fixed, and no single perspective is definitive. For purposes of this study and to build a connection between entrepreneurial action and teaching, I provide a perspective offered by Spinosa, Flores, and Dreyfus (1997) in their book Disclosing New Worlds: Entrepreneurship, Democratic Action, and the Cultivation of Solidarity. Spinosa, Flores, and Dreyfus spend the first two chapters describing how they define and see entrepreneurship. The perspective they offer on entrepreneurship and entrepreneurial action provides a pathway for connecting entrepreneurship to education and specifically to teaching. The authors of this book have intellectual backgrounds that cross several domains: Spinosa is a former English literature and philosophy professor; Flores is an engineer, entrepreneur, and politician; and Dreyfus is a philosopher. They explain that not all
change should be considered entrepreneurial. To help illustrate their point, they provide the following example to distinguish an entrepreneurial change from another type of change and highlight the notion of transmuting values:

A research department may review the numbers of the aging baby boomers and set out to develop a new fabric that keeps people warm, on the view that older people get chilled more easily. But this does not “transmute values.” It does not open a new space for human action. The entrepreneur is the person who develops a cold weather activity that elderly people subsequently seek out and that changes the way the elderly see themselves, their bodies, and their lives. (p. 37)

Spinosa, Flores, and Dreyfus’s clarification provides an opening to see how teachers might become entrepreneurial. If terms are borrowed from this example, one might say educators who “open new spaces for human action,” who develop activities for students to see subjects and concepts in a new light, and who “transmute values” of their subject or area of expertise are entrepreneurial. An entrepreneur, Spinosa et al. argue, is someone who creates an activity or product so compelling that people are drawn to it, and the activity or product becomes part of a person’s life. It can even change how people see themselves and their identity. If educators act as entrepreneurs as defined by Spinosa, Flores, and Dreyfus, their students will have opportunities to experience what they are learning, their students will seek to learn more, and they will gain an appreciation for the subject itself. The values of the educators are no longer just the educators’ alone; the values are now shared with students. This transmuting of values is what makes Spinosa, Flores, and Dreyfus’s perspective of an entrepreneur compelling and helpful in framing the study. The concept of value creation, which they argue is critical to
an entrepreneur, has also been cited as being essential to the educational process. The work of Japanese educational scholar Makaguchi explains that value creation is an essential aspect of community building and education (Goulah & Gilbert, 2009).

The argument could be made that almost all teachers desire to transmute value to their students, and the question could be asked, “Don’t all teachers want students to see the content they are learning as important and meaningful?” There is a difference between an educator who wants to or attempts to transmute values to his or her students, and an educator who works hard to achieve transmuting value by going beyond the standard expectations for teaching the content and opening new spaces for learning. It is the combination of opening new spaces and transmuting value that are essential components of the example of an entrepreneur given by Spinosa, Flores, and Dreyfus.

In their work, Spinosa, Flores, and Dreyfus go on to distinguish between an entrepreneur and entrepreneurial activity. The definition they provide requires an entrepreneur to change people’s values and bring about a historical change. The entrepreneur, they explain, is someone who can link the ability to innovate with the ability to manage an enterprise (p. 45). Spinosa, Flores, and Dreyfus characterize, “… genuine entrepreneurs as people who make historical change by producing both a product that solicits people to change the style of their everyday activities and a company that instantiates the new way of life the product establishes” (p. 34). Entrepreneurs operate much like others in the course of human activity; however, they recognize and are captivated by anomalies, stick with the anomalies with intense personal commitment, have a heightened sense of what is happening with these anomalies, and are able to institutionalize a new product or service as a result of this heightened attention to these anomalies.
To connect this with teaching, teachers who work to transmute value will recognize when students are not connecting with material, and they will create new or additional learning experiences and spaces for students to increase the value of a subject. These activities will provide students with different learning experiences. Consider two different math teachers. The first math teacher is teaching the content and recognizes that students are acquiring the knowledge, but the teacher realizes the students don’t seem to appreciate the material, are unable to apply the content to the world around them, and do not see the content as relevant. This teacher has a strong desire to change the situation, but the limitations of the school day, the available time, and the need for content coverage impedes him or her from going any further to address this issue. The second teacher sees the same issue, but this teacher sticks with the problem. The second teacher works to create opportunities for students to perceive and experience the value of the content, attracts the students to participate in additional learning experiences, increases students’ value for the content, and/or provides students the opportunity to apply what they are learning to the world around them. This second teacher works with an intensity and creativity to bring a new and additional educational opportunity to students and opens spaces for learning that go beyond standard classroom teaching—the second teacher is acting entrepreneurially.

Spinosa, Flores, and Dreyfus offer the view that a “genuine” entrepreneur is limited to those who make historical change. For the purposes of this study, I was less interested in studying those who had made a historical change in the field of education and more interested in the entrepreneurial actions that teachers were taking to create new learning opportunities for students. The intent of this study was not to label these teachers as entrepreneurs or to define the transition from entrepreneurial activity to entrepreneur (although more research in this area may
be warranted). The intent of this study was to investigate the entrepreneurial action underway and the learning opportunities created.

**Empirical studies on educational entrepreneurship.** The educational entrepreneurial literature dives further into the challenges facing the rise of entrepreneurs within the school system. Educational entrepreneurship is getting more attention in the literature (Borasi & Finnigan, 2010; Chand & Misra, 2009; Hess, 2006, 2008; Sandler, 2010). Some of the educational entrepreneurship literature focuses on entrepreneurship success stories and offers conceptualizations about educational entrepreneurship (Hess, 2006, 2008; Sandler 2010; Cuban, 2006). Other literature includes empirical studies around the concepts of educational entrepreneurship (Borasi & Finnigan, 2010; Chand & Misra, 2009). This section is devoted to the empirical research on educational entrepreneurship. In Table 2.1, I include a summary of the empirical studies reviewed. These educational entrepreneurship studies focus on K–12 schools as well as higher education.

Table 2.1

*Summary of Educational Entrepreneurship Studies*

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Type of Study</th>
<th>Location and Context</th>
<th>Participants</th>
<th>Summary of Key Findings</th>
</tr>
</thead>
</table>
| Borasi & Finnigan| 2010 | Qualitative: Multiple case studies | Varying contexts in United States | Six entrepreneurial educators (principal, school leader, teacher, dean in higher education, nonprofit CEO, and business owner) | • Are driven by vision.  
• Relentlessly engage in innovations.  
• Are alert and ready to seize opportunities.  
• Are not constrained by resources.  
• Are masters at networking.  
• Make quick and timely decisions.  
• Practice creative problem solving.  
• Confidently take risks.  
• Find champions for each innovation.  
• Capitalize on crisis and dysfunction. |


Table 2.1 (cont.)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Study Type</th>
<th>Research Population</th>
<th>Sample Size</th>
<th>Findings</th>
</tr>
</thead>
</table>
| Chand & Misra              | 2009 | Qualitative: Case studies | Primary schools in India                                  |             | • There is a link between the action of teacher entrepreneurs and actions of social entrepreneurs.  
• School context impacts activity.  
• Resource mobilization is important.  
• Opportunities connect to local cultural experiences.  
• Teachers partner with the community.  
• Teachers develop own resources for use within the classroom. |
| Van Dam, Schipper, & Runhaar | 2010 | Quantitative: Survey design | 225 vocational schools in Netherlands                      | 607 teachers surveyed with 251 responding | • Career adaptability and creative thinking were strongly related to entrepreneurial behavior.  
• Knowledge of entrepreneurial behaviors helped teachers exhibit these behaviors.  
• Teachers’ networking skill and teamwork predicted entrepreneurial behavior.  
• Occupational self-efficacy did not seem to impact entrepreneurial behavior. |
| Ali, Topping, & Tariq      | 2009 | Quantitative: Survey design | 7 teacher preparation programs in Pakistan universities   | 516 prospective teachers from multiple universities in Pakistan responded | • Prospective teachers at all universities indicated higher entrepreneurial intent.  
• Prospective teachers from rural areas showed higher entrepreneurial intent than those from urban areas.  
• Prospective teachers in master’s-level programs were higher in entrepreneurial intent. |
| Bresler                    | 2009 | Qualitative: Inquiry | Graduate course using cases of academic intellectual entreprenur in United States | Academic intellectual entrepreneurs (AIE) | Academic intellectual entrepreneurs  
• have a vision and passion.  
• learn experientially.  
• animate and lead others.  
• are creative.  
• shape and are shaped by their endeavors. |

**Actions of entrepreneurial educators.** Through the review of the empirical literature on teachers as entrepreneurs, it became apparent that several entrepreneurial actions were present within and across the scholarship and could be used to frame teachers acting entrepreneurially in order to bring new learning opportunities to their students. These include (a) focus on an area of
intense interest with determination, (b) use existing and secure new resources, (c) engage and animate others; and (d) view learning as experiential.

**Focus on an area of intense interest with determination.** Within the empirical research, there is support for the idea that entrepreneurial teachers work on an area of intense interest and do so with determination. In Ali, Topping, and Tariq’s (2009) research with preservice teachers, internal locus of control, a belief that one has the ability to control events and make a difference through an applied effort, was an important factor in entrepreneurial development. In the cases studied by Borasi and Finnigan (2010), entrepreneurial educators were found to be driven by a vision motivated by a greater purpose and linked to underlying goals and philosophies of the educator. Chand and Misra (2009) found that some teachers’ entrepreneurial efforts were built upon “teachers’ use of their own traditional skills and interests” (p. 226).

**Use existing and secure new resources.** Teachers, to gain the necessary support for their entrepreneurial initiatives, may need to identify and acquire resources. Borasi and Finnigan (2010) state that none of the educators in their study “let their available resources determine their decision of whether or not to move forward with a specific innovation” (p. 18). The educators, instead, looked around and saw existing resources that could be put to use or sought out new resources. Chand and Misra (2009) found that “mobilisation of resources from the community may sometimes act as a ‘spur’” (p. 225).

**Engage and animate others to act.** If entrepreneurs are to generate support for a shared belief, commitment, and action toward a vision based on their interests, they need to reach out to others. Dam, Schipper, and Runhaar (2010) found that “teachers’ networking skill contributed to the prediction of entrepreneurial behavior” (p. 969). Networking implies an ability to reach out
and make connections. In order to generate shared action toward the goal, something beyond networking might be important.

Those educators who are able to get others deeply involved, active, and committed are labeled “animators” by Bresler (2009). Bresler’s work was focused on the work of academic entrepreneurs, and she states, “The concept of animation captures the function of intellectual entrepreneur as working with others to inspire, negotiate, and lead in making things happen” (p. 19). This reaching out and animating others might be labeled differently in the different empirical studies. In the cases they studied, Borasi and Finnigan (2010) found that entrepreneurial educators were able to find champions for their innovations. These champions were willing to dedicate their time and services to building the initiatives.

**View learning as experiential.** In the business entrepreneurship literature, it has been argued that entrepreneurs typically embrace failures as opportunities (Drucker, 1985). The process of failing provides unique insights that are fertile ground for the entrepreneur to learn and, if needed, change direction. Bresler (2009) refers to this learning from failure as part of an experiential learning process that is central to entrepreneurs. In order to overcome the failures, Bresler explains, unwavering persistence and focused attention are critical and are what sustains the entrepreneur to continue to make progress.

The empirical research has provided some prior findings in order to build upon. One of the key findings from Dam, Schipper, and Runhaar’s (2010) research with vocational teachers focuses on the importance of entrepreneurial environment. “Teachers engaged in entrepreneurial behavior more when they perceive a climate that stimulated and supported this behavior” (p. 970). The environment in which teachers teach is an important consideration when conducting research on entrepreneurial teaching.
Impact of Institutional Structure and Culture of Schooling on Entrepreneurial Activity

The setting of low-income schools served as the setting for the two cases, and the entrepreneurial literature provided some background on the institutional structures of schooling, the culture of schools, and the moral purpose of teaching. Sarason, Dean, and Dillard (2006) proposed structuration theory as a lens through which to view the entrepreneurial process. I provide a brief overview of structuration theory to illustrate the impact structures have on individual action. Structuration theory, first proposed by Giddens (1984), explains that human action is shaped by social structures, and social structures are shaped by human action. The rules, resources, and routines of a social structure have great power over the actors operating within the structure; however, that does not mean that the human actors are powerless since human actors do have the power to enact change and impact the structures in which they operate. These structures, once they become formal and operate as institutions, have an impact on entrepreneurial behavior (Lanza, 2004; Welter & Smallbone, 2011). When thinking of school structures, the budgetary and public service commitment, a culture of standardization and consistency, the moral purpose of teaching, and the issues inherent in low-income schools serve as potential hindrances for teachers acting entrepreneurially.

Budgetary and public service commitment. The difficulty of being entrepreneurial within governmental institutions has been highlighted in entrepreneurial literature focused on business (Dees, 2007; Drucker, 1985) as well as social entrepreneurship (Bornstein, 2007). Bornstein states, “Social entrepreneurs occasionally can be found in government and academia, although the incentive structures and institutional constraints act as deterrents” (p. 241). Drucker provides the following reasons why entrepreneurship is difficult particularly when it comes to “service” organizations:
1. The institution operates on a budget rather than being paid based on results.

2. The institution depends upon a variety of constituents.

3. The institution exists to do good. “This means they [institutions] tend to see their mission as a moral absolute rather than as economic and subject to cost/benefit calculus.” (p. 179)

Schools operate as public service organizations, and budgetary issues often drive the decisions made. Schools are managed by school board officials elected by the community or appointed by higher-level government officials, and the decisions school boards make are subject to the support or disdain of community members, parents, and political parties. This pressure limits a school board’s ability to spend taxpayer dollars to engage in cutting-edge innovations. Those who wish to take entrepreneurial action must identify areas of support beyond those offered within the bureaucratic system of schools.

Cuban (2006), focusing on entrepreneurship in schools, provides the following perspective on the challenges when it comes to educational entrepreneurship:

1. Since the early twentieth century, educational entrepreneurs have made major changes in U.S. public school goals, governance, organization, and curriculum.

2. With all of these major changes in schools, educational entrepreneurs, past or present, have seldom altered substantially or permanently classroom regularities and low-income students’ academic achievement.

3. Current educational entrepreneurs’ efforts toward making radical changes in governance and preparation of school leaders have ended up preserving present organizational structures and school practices in urban schools.
4. Current educational entrepreneurs’ commitment to a narrow economic purpose for schooling has seriously neglected civic and social purposes that have historically integrated schools into community life. (p. 224)

**A culture of standardization and consistency.** An institution is made up not just of the structures, systems, and hierarchy, but also its culture. Geertz (1973) defined culture as “an historically transmitted pattern of meanings embedded in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and attitudes toward life” (p. 89). Building on the work of organizational psychologist Edgar Schein, Deal and Peterson (2009), state, “School cultures are complex webs of traditions and rituals built up over time as teachers, students, parents, and administrators work together and deal with crises and accomplishments” (p. 7). Deal and Peterson use the term *work together*, which assumes cohesion, but the political conflicts (either apparent or flowing unnoticed) inherent within school cultures become an important consideration. Schein (1973), who focuses on culture in a variety of organizations, explores whether people can change organizations or if only *people* within organizations can be changed. He explains that organizations have goals they are held accountable for, and these are an organization’s manifest functions. They also have goals society expects of them, which are their latent functions.

When looking at schools since NCLB, one might argue that the manifest function of teaching and of school is clearly connected to student performance on high-stake tests. When it comes to the latent functions, society wants schools to be providing education that will help students be competitive for jobs and become dependable citizens; some, as Schein points out, want schools to provide places for care and control of children (p. 783). Within an organization,
different members connect more closely with the different functions, and this may create conflict. Administrators charged with raising test scores may be in direct conflict with teachers who see their purpose as providing a caring environment for student growth and exploration. Gordon and Patterson (2008) state, “Schools are influenced by the larger social and economic contexts in which they are embedded” (p. 33). This influence not only impacts the organization of schools, but it also influences how each member within a school sees his or her function. The culture inherently includes competing ideals and agendas. Hargreaves and Goodson (2006) looked at school change over the course of 30 years, and they concluded, “In our study, standardization is proving to be the ultimate enemy of enduring innovation and sustainable learning communities” (p. 34).

Another structural element within compulsory public schools is a desire to provide a consistent school experience for each child. The idea that children are products and should leave the school setting with a rubber-stamped, shared educational experience has been highlighted in some literature dealing with school culture. Fink and Stoll (2005) speak of the structures and consistencies expected within schools:

*Such solutions are exceedingly rational but they dew the individuality of both teachers and students. It is as though someone has decided that all eight year olds should all have the same shoe size, the same interests, or the same needs. It suggests that there are absolute scientific rules of teaching and learning which supersede the professional judgements of teachers in classrooms* (p. 28).

Teachers’ and students’ individual autonomy has been lost in the interest of creating a consistent experience for all students. This commitment to similar people doing similar work echoes the
office worker notion highlighted by Schumpeter. People committed to a consistent experience and routine, Schumpeter argues, rarely have the vision and ingenuity to facilitate innovation and be entrepreneurial.

If indeed a teacher does possess the internal drive and has created an entrepreneurial concept based on a passionate interest, the teacher may create unique learning experiences for students. However, success is not guaranteed. The culture of schooling and expectations of school teaching present challenges. Tyack and Tobin (1994) discussed the “grammar” of schooling and the power of the institutional forces at work. If one walked into a typical American high school in the 1950s, one would find hallways of classrooms, certain sections of the hallways devoted to the different major disciplines, bells signaling the time to pass to the next period, lockers lining the hallways, students carrying large books from class to class, and a grading system with report cards. Fast-forward 60 years and one would still find a similar system in place. Of course change has occurred; however, the institution of schooling and many of its structures remain in place. There are pockets of change, as pointed out by Tyack and Tobin, but those pockets often do not have the staying power and soon collapse and return to the standard approach to schooling. It might be assumed that the routine of schooling is a powerful force difficult to alter, and a force that makes it difficult for teachers to introduce new ideas. Darling-Hammond (2005) stated, “When teachers try to develop more challenging instruction and attend to the individual needs of students, their efforts bump up against traditional schedules, discipline policies, grading and promotion procedures, and virtually everything else that defines the schooling enterprise” (p. 369).

When it comes to facilitating change in schools, Hargreaves and Goodson (2006) reviewed data that included interviews from over eight secondary schools that spanned two
countries and was from over three decades of research. Their goal was to look at change over time. Key findings that emerged included these:

- Teachers’ commitment to change weakened over time as they saw waves of reforms that seemed contradictory and lessened their belief in the power of change.

- School leadership frequently changes, and the role of school leadership has become that of “anonymous managers” (p. 21). With multiple leadership changes, initiatives supported by one leader were discontinued with the arrival of another.

- Economic times, standardization, and changing demographics have a huge influence on the resources and abilities of schools and teachers to change.

Tyack and Tobin (1994) and Hargreaves and Goodson (2006) give insight into the power of the status quo as well as the challenges in generating support for change. Fink and Stoll (2005) consider the issues just listed as being “forces of continuity.” They explain that particularly over the last 15 years, teachers have been flooded with failed innovations and change projects; teachers are under increased scrutiny by “nested layers” of control and are faced with government mandates, economic pressures, and rapid technological advances. As the competing agendas of change are put forth in schools, Fink and Stoll argue, the result is teachers distrusting the changes and in some cases becoming resistant. The forces of continuity are strong, and as a result, “in spite of the convergence of powerful forces for change, schools appear remarkably untouched, and exhibit many structures, policies and practices of years gone by” (p.18).

In the event that a teacher has decided to take action on an area of intense interest in order to facilitate a new learning experience and break away from the forces of continuity, the next two steps for pursuing entrepreneurial endeavors become difficult. An entrepreneurial teacher would need to challenge the status quo and animate others to act.
It has also been noticed that teachers may have a clear vision of what their function should be based on pedagogical principles; however, the reality of the school day, the number of students, and the limited time may mean that teachers abandon their ideals in order to ease their burden. Erickson (1987) provides the example of the elementary teacher who reverts to using a basal reader rather than creating a reading program that moves beyond being simplistic and prescriptive. He explains that teachers may opt for this approach even when it runs counter to their values and pedagogical principles for the convenience, the ability to lessen their burden, and the control that seat work offers during the course of a hectic school day. Erickson also highlights that the curriculum and materials may have been purchased by the district and handed down to the teacher. Rather than critically reviewing the materials, the teacher may passively accept the curriculum in a move that conserves his or her energy. Fink and Stoll (2005) explain that over time, teachers have failed to be consulted when it comes to curriculum and school change. The schools’ commitment to the manifest function of testing has resulted in curriculum being aligned to testing, and as a result, the expectation is that the teachers deliver the material and prepare students for those tests. The pedagogical role of the teacher has been reduced and might now be considered a “tradesperson” (Fink & Stoll, 2005). The teacher’s role is to pick up the developed curriculum and plug it into the classroom, and the student’s chug along. When teaching becomes scripted, the ability of the teacher to create and innovate becomes limited at best.

**Moral purpose of teachers.** The culture of schools includes the underlying value systems that teachers bring to the profession of teaching. Higgins’s work on the ethics of practice in relation to the teaching profession provides a sound introduction to both the culture and moral purpose that connects teachers to the profession of schooling. Higgins (2011) states,
“Within the ethos of a culture and age, one finds a hierarchy of fundamental goods guiding its sense of what is worth striving for in human life” (p. 63). The ideals of a culture often connect with the ideals of the individual. Higgins asks, “What is the life of the teacher and how does this relate to my sense of what makes life worth living?” (p. 179). For teachers, it is argued, the goal of becoming a teacher is tied to altruistic values and a sense of duty. Teachers place life and self-interests aside, and often allow the teaching of students and their classrooms to consume their lives (p. 184).

In many instances, an entrepreneur focuses on an area of intense, personal interest. If a teacher’s sense of moral purpose is tied to altruism and duty, the possibility is that he or she begins to abandon his or her own self interests and focuses solely on the students. This lack of intense personal interest presents a challenge if teachers are to become entrepreneurial. If teachers only focus on the interests of students and schools, then they may not have the stamina to navigate the difficulties of an entrepreneurial activity. The drive is not internal, and the external drive may not be strong enough to move past the obstacles of creating something new within the culture of schooling (Pink, 2009). This is not to say that teachers must choose between an internal drive and the interests of their students; however, teachers may find it difficult to trust their internal drives and interests and recognize that the intense pursuit of a personal interest might have educational value for their students.

**Issues of low-income schools.** If a context of a school includes issues of poverty and repeat failure based on the accountability measurements, the culture may breed more failure, thus making innovation and change even more difficult. Raising academic achievement in low-income areas has been a central concept in NCLB and the subsequent Race to the Top. Failure to meet the benchmarks results in school sanctions and in some cases, school closure. As
sanctions are imposed on low-performing, low-income schools, the teachers, students, and schools face failures that are demoralizing and result in negativity, guilt, and short-term, misguided solutions (Mintrop & Sunderman, 2009). The challenges are well documented, as Payne (2010) noted in his exploration of the difficult context of facilitating academic change in schools and communities that are considered high poverty and academically failing. Such environments, Payne states, “can create a social environment that encourages yet more failure, one downward spiral generating another. At the same time, positive synergies can be slow to come, if they come at all; one positive development does not necessarily lead to others in an unsupportive environment” (p. 45).

**Experiential Learning and Reform-Minded Science Teaching**

As performance on high-stake tests becomes the target outcome of learning, science teachers might rely more upon having students read textbooks and memorize content that closely align with the testing expectations. Wyss, Dolenc, Kong, and Tai (2013) conducted research on the use of biology textbooks in high schools using surveys of 2,712 first-semester college students enrolled in biology courses at 55 different four-year colleges and universities. Almost 65% of the students reported reading their science textbooks between 20 to 50 minutes a day; however, the amount of time devoted to reading did not improve grades or performance on the ACT. In their article, *Time on Text and Science Achievement for High School Biology Students*, the authors state,

> *Because the use of textbooks does not seem to be related to knowledge gains beyond those offered through alternative methods, and existing studies show that alternative techniques in the classroom offer benefits beyond academics, it seems that expanding the use of alternative methods could be beneficial. It is reasonable*
to expect that this finding may apply to other content areas, and not just the science classroom, but research that is specific to those areas of study should be conducted in order to investigate the possible impacts. (p. 56–57)

Methods pulled from experiential learning theory might offer the alternative methods that Wyss et al. cite in their study. Kolb (2000) emphasized that experiential learning is a process of learning through experiences that is not concerned with behavioral outcomes such as performance on high-stake tests. In fact, he argued that the emphasis on outcomes is an example of nonlearning since those receiving the education are not necessarily reshaping their own ideas, habits, or views of the world. Experience along with reflection is central to learning and helping people to reshape how they think, feel, perceive, and behave. Kolb recognized that experiential learning was occurring in many different human settings, and he stated, “Learning is the process whereby knowledge is created through the transaction of experience” (p. 331).

Incorporating experiences into the science classroom, it has been argued, helps students learn more science (Burkam, Lee, & Smerdon, 1997). Using data from a large-scale, longitudinal study of 25,000 students collected in 1988 and 1990, they found that “our multivariate models provide solid evidence that students learn more in science classes that include regular laboratory activities, where students are actively engaged in such activities as writing up lab reports and performing their own experiments (rather than merely watching the teacher do them)” (p. 322). At the end of their research, they pose a series of questions asking why these experiences are not more prevalent in high school classrooms (p. 328). Their questions may connect with the structures of schooling addressed earlier in the chapter, and the conditions may be why some teachers and educators are choosing to create new spaces for experiential learning that extend beyond classroom and school.
This recommendation for students to have active experiences with science was included in Rutherford & Ahlgren (1989) *Science for All Americans* as well as the release of the *National Science Education Standards* (NSES) by the National Research Council (1996). Rutherford & Ahlgren stated, “Scientists, mathematicians, and engineers prize the creative use of imagination. The science classroom ought to be a place where creativity and invention—as qualities distinct from academic excellence—are recognized and encouraged” (p. 191). NRC stated:

*Learning science is something students do, not something that is done to them. In learning science, students describe objects and events, ask questions, acquire knowledge, construct explanations of natural phenomena, test those explanations in many different ways, and communicate their ideas to others.* (p. 20).

NRC defined, “Science literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (p. 22). Based on this definition, to gain literacy students need to move beyond knowledge and understanding of scientific concepts and begin to recognize how science can influence the world around them. The standards recommended changing the learning emphases within the existing traditional science classrooms. They recommended shifting away from classroom practices such as students working in isolation, teachers lecturing and rigidly following the curriculum, and using tests over factual information within the textbooks, and moving toward students using scientific knowledge to inquire about the world around them, the teacher sharing responsibility for learning with students, and supporting a classroom community with cooperation, shared responsibility, and respect (p. 52). The move for teachers to begin to incorporate more active experiences that align with the recommendations outlined by NRC and Rutherford & Ahlgren has been called reform-minded science teaching.
NSES recognized that time, space, and resources would be critical components of achieving reform-minded science teaching:

*Time, space, and materials are critical components of an effective science learning environment that promotes sustained inquiry and understanding.*

*Creating an adequate environment for science teaching is a shared responsibility.*

*Teachers lead the way in the design and use of resources, but school administrators, students, parents, and community members must meet their responsibility to ensure that the resources are available to be used.* Developing a schedule that allows time for science investigations needs the cooperation of all in the school; acquiring materials requires the appropriation of funds; maintaining scientific equipment is the shared responsibility of students and adults alike; and designing appropriate use of the scientific institutions and resources in the local community requires the participation of the school and those institutions and individuals.  (p. 43).

In order to have adequate time, find spaces, and acquire resources for reform-minded teaching, teachers may need to go beyond the existing structures of schools. Kolb and Kolb (2005) recognized the need for new learning spaces that provide experiences and time for reflection. In order to provide experiential learning opportunities, Kolb promotes the creation of learning spaces that promote “growth-producing experiences for learners” (p. 205). Using Lewin’s field theory, Kolb explained that there are forces that greatly impact a person and his or her environment. Those wishing to create these spaces for experiences, including reform-minded science teachers, must be cognizant of the forces at work and find ways to navigate those forces in order to create these experiential learning spaces. Educators who want to provide unique
science learning opportunities may choose to navigate a path that takes them outside of their classrooms.

**Rise of Informal Learning to Give Students Active Experiences**

With an increased focus on ever-improving student performance on high-stakes tests in what have been labeled core subjects and the decrease in available funding for schools, several school subjects considered to be extracurricular, for example music, art, physical education, and vocational education, have been cut or largely reduced from the school offerings. With these school subjects being forced out of schools given the institutional constraints, there has been a rise in beyond-school programs that focus on these subjects and fall into a category of learning that Marsick and Watkins (1990) labeled informal learning:

*Formal learning is typically institutionally sponsored, classroom-based, and highly structured. Informal learning, a category that includes incidental learning, may occur in institutions, but it is not typically classroom-based or highly structured, and control of learning rests primarily in the hands of the learner.*  (p. 12)

Heath and Soep (1998) studied after-school programs focused on the arts, athletic, and community service over seven years and within communities that were struggling with poverty and dwindling employment. They focused on figuring out what characteristics of the programs led to their success over the seven years as well as what attracted students to the programs. In contrast to some school subjects that are required for graduation, these programs were all voluntary for the youth. They chose to attend these learning experiences and even sought them out on their own. Heath and Soep determined the following:
In short, community organizations judged by local young people to be effective learning environments were marked by a mix of features relating to roles, rules, and risks undertaken by the young. In their push toward outcomes of excellence, the youth carried most of the weight of the performance, assumed multiple roles and responsibilities, and followed a rule of conduct based on an organizational ethos of belief in young people as resources. (p. 11)

At the center of the after-school programs deemed successful was learning based upon giving students active experiences with the subject matter. When focusing on the arts-based after-school programs, the students participated in activities that had them prepare, plan, practice, perform, and evaluate. The process described in Heath and Soep’s research aligned with experiential learning theory.

Beyond-classroom and school science programs have been given some attention in the empirical research (Markowitz, 2004; Mulkerrin & Hill, 2013; Handler & Duncan, 2006). Two studies provided students with informal, experiential science learning during the summer, and one was during the school year; however, students were on a four-hour academic block and participated in the class at a local zoo (the science class met for four hours twice a week). The studies indicate the positive impact these experiential learning experiences had for students. In order to create these opportunities, educators created new, different spaces outside of the classroom to provide students with experiences connected to science.

Creation of Third Spaces for Innovative Learning

Teachers, as it has been established, work within bureaucratic structures that make creating innovative opportunities for students difficult given the perceived and/or real constraints of the system. Bhaba (1994) offers a conceptualization of a third space that operates beyond
oppressive forces that divide cultures. He states that the third space allows people to operate without the imposed hierarchies, interact with one another without the fixed identities common in traditional structures, and provide the possibilities for cultural hybridity (p. 5). In the case of teachers and students, if the classroom space is not providing the ability for teachers to share, communicate, and transfer learning, then they might seek out places in which they can work together with students to share this culture associated with their disciplines.

Several education scholars have conducted empirical research around the idea that creating third spaces in education would provide valuable learning opportunities for students (Emdin, 2009; Gutiérrez, 2008; Hallman, 2012; Lipka, et al., 2007; Moje, et al, 2004; Quigley, 2011). Emdin (2009), focusing on urban science education, states that the structures, rigid curriculum, and focus on facts in the urban science classrooms cause students lose a sense of agency and connection to science and recommends that teachers create third spaces in which students have opportunities to communicate more openly, work on issues that have value to the students, and provide students with a chance to have responsibility. To create these third spaces, teachers need to identify available resources but they also need to create spaces that attract students and youth.

**Opportunity for Research in Educational Entrepreneurship**

Given an institutional system that has remained consistent over many years as well as changing leadership, skeptical teachers, and economic constraints, a teacher faces a difficult situation when creating experiential learning opportunities that break free from traditional schooling. Within the current research along educational entrepreneurship, there are two distinct areas of emphasis. The first is focused on educational reform initiatives by outside
organizations; the second is rooted more in social entrepreneurship. I offer both to situate this study.

Hess (2006, 2008) has edited two books that cover entrepreneurship in the context of schools. Recently, Sandler (2010) published another book on entrepreneurial private ventures in relation to education. Many of the examples provided in these books include outside organizations moving into the current public school system with hopes of producing reform within the system. Examples include charter schools, technology companies, and alternative certificate programs. It is important to recognize that these organizations are indeed new to the education system, but how unique and innovative they are is up for debate. Some charter schools resemble the colonial educational system and include uniforms, rigid rules, zero tolerance for misbehavior, and adherence to a structured curriculum aligned with testing. Saltman (2012) argues this type of entrepreneurship is detrimental to the democratic notion of public schools and says that venture philanthropy initiatives, such as those described previously, “need to be recognized for their hostility to public and critical forms of schooling as well as their alignment with the broader movement to privatize and dismantle public schooling” (p. 76). Privatized schooling is not innovative or new, but rather is a return to the historical model of schooling. The organizations recognized as entrepreneurial by some of the educational entrepreneurial literature are reinstitutionalizing an old educational system rather than building upon an innovation.

A limitation within this existing educational entrepreneurship literature is that it pays little attention to the entrepreneurial activity within the system and/or school, and this activity is even seen as potentially impossible. Rogers’s (2003) pivotal work on innovation and the spread
of it within cultures illustrates the importance of innovation that is closely connected to the
culture in which it is to be adopted.

This distinction between corporatized models of schooling and social entrepreneurship
rooted in education is essential and a significant difference between the focus of this study and
prior research labeled “educational entrepreneurship.” Innovation is essential when considering
the definition of entrepreneurship. There is some research that sheds light on teachers who
pursue entrepreneurial endeavors (Borasi & Finnigan, 2010; Chand & Misra, 2009; Hess, 2006,
2008; Sandler, 2010). The disconnect between the educational entrepreneurship literature and
entrepreneurial examples from within the system warrants further attention. If the research focus
is specifically on teachers who are entrepreneurial within the context of schools, the available
research is much more limited.

**Shifting Research Focus From Competencies of Entrepreneur to Entrepreneurial Activity**

At the onset of this study, I worked with several other scholars to develop a competency
framework of entrepreneurial teacher leaders (see Appendix A, Figure 2.2, and Table 2.2).
Through the review of the literature as well as collaboration with members of a research team, an
initial framework for an Entrepreneurial Teacher Leader’s Conceptual Framework was
developed, and this framework was presented at the National Science Foundation’s Math
Science Partnership Conference in Washington, DC, in January 2010 (Koehler et al., 2010). In
addition to the framework, we created a table of definitions to help clarify the way that the terms
were used within the framework (Table 2.2). A variety of entrepreneurial literature served as a
foundation for the framework, and this initial review of the literature also helped create the initial
interview protocol for the study (Appendix A). I include the initial framework because it shaped
the ongoing review of entrepreneurial research and literature and the beginnings of the study, and
it offers important elements of prior research in the field of entrepreneurship and its intersection with education.

Figure 2.2 The Entrepreneurial Teacher Leader’s Conceptual Framework presented NSF-MSP Conference, Washington, DC.
### Table 2.2

**Definition of Terms Within Entrepreneurial Teacher Leader’s Conceptual Framework**

<table>
<thead>
<tr>
<th>Competency</th>
<th>Definition</th>
<th>Source(s)</th>
</tr>
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<tbody>
<tr>
<td><strong>Personal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accountable Efficacious</td>
<td>Behaves in a way that demonstrates belief that he or she possesses the skills, abilities, and expertise to handle challenges, overcome obstacles, and achieve goals, as well as the belief that he or she is responsible for taking action.</td>
<td>Locke &amp; Baum (2007, p. 98) Markman (2007)</td>
</tr>
<tr>
<td>Action Oriented</td>
<td>Takes initiative and is proactive when implementing an idea or goal and does so with planning (can be real-time, everyday planning). As Frese (2007) explains, an active approach is critical for an entrepreneur.</td>
<td>Frese (2007) Schumpeter (1942/2011)</td>
</tr>
<tr>
<td>Committed Passionate</td>
<td>Identifies and engages in the idea and demonstrates a desire to remain with an idea during difficulty, a willingness to apply significant effort, and an emotional attachment to the idea.</td>
<td>Tang (2008)</td>
</tr>
<tr>
<td>Creative</td>
<td>Demonstrates creativity: “Creativity is any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one” (Csikszentmihalyi, 1996, p. 28). Applies novel ideas or approaches to practice and embraces ambiguity.</td>
<td>Csikszentmihalyi (1996)</td>
</tr>
<tr>
<td>Self-Aware</td>
<td>Is reflective and mindful of existing mental models and shows willingness to adapt when confronted with surprises or challenges.</td>
<td>Gaglio &amp; Winter (2009)</td>
</tr>
<tr>
<td>Visionary</td>
<td>Recognizes opportunities in situations in which others have seen problems. Entrepreneurs “believe in a yet-to-be-made future that can be substantially shaped by human action” (Sarasvathy, 2005, p. 9). Hougaard states, “As an entrepreneur, you can see what might be, and not just what actually is—you have the ability to glimpse the future relations between factors that may create new value and new opportunities” (p. 8). Bresler (2009) explains that vision “often crosses borders, disciplinary and others” (p. 17).</td>
<td>Hougaard (2005) Bresler (2009) Sarasvathy et al. (2003) Sarasvathy (2005)</td>
</tr>
<tr>
<td><strong>Relational</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaborative</td>
<td>Exhibits collaborative behaviors. “Entrepreneurs need also to use collaborative strategies (e.g., alliances) and shield their new ventures from the adversity of their hostile external environments” (Zahra, p. 62). Credit for accomplishments and ideas are shared.</td>
<td>Zahra (2006) Bornstein (2007)</td>
</tr>
<tr>
<td>Empathetic</td>
<td>Shows “awareness of others’ feelings, needs, and concerns” and builds this awareness through active listening and careful observation of others (Goleman, 1998, p. 27). Demonstrates willingness to look carefully at differing points of view.</td>
<td>Goleman (1995)</td>
</tr>
<tr>
<td>Influential Animator</td>
<td>Builds a collective passion through the “ability to change others’ attitudes and/or their behavior in desired directions” (Baron &amp; Markman, 2000, p. 110). Is able to activate others toward a shared vision. Bresler (2009) defines animation as “... working with others to inspire, negotiate, and lead in making things happen” (p. 19).</td>
<td>Dnovsek, Cardon, &amp; Murnieks (2009) Baron &amp; Markman (2000) Bresler (2009)</td>
</tr>
</tbody>
</table>
As the review of literature continued and more time was spent talking with participants in the study, the competencies of an entrepreneur seemed to be less critical to the study. Identifying the competencies of entrepreneurs is a research activity rooted in psychology (Gaglio & Winter, 2009; Krueger, 2005; Locke & Baum, 2007). Since this research study was not intended to be psychological, the research became more focused on the entrepreneurial activity of the teachers described in the cases, the behaviors associated with creating those activities, and the spaces the teachers created for their students. The personality and competencies of the teachers moved to the background, and as Drucker (1985) states, “It (entrepreneurship) is not a personality trait; in thirty years I have seen people of the most diverse personalities and temperaments perform well in entrepreneurial challenges” (p. 25–26). Drucker argues entrepreneurship is about people’s

### Table 2.2 (cont.)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Description</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflexive</td>
<td>Analyzes the environment, situation, and relationships in connection with vision and/or behavior. As a result of this reflection, changes the course of action. Bornstein terms this an “ability to self-correct” (p. 234).</td>
<td>Bornstein (2007) Tsoukas &amp; Chia (2002)</td>
</tr>
<tr>
<td>Trustworthy</td>
<td>Gains the confidence of others through effective problem solving, achieving results, sharing leadership and decision making, and respecting others.</td>
<td>Wahlstorm &amp; Louis (2008)</td>
</tr>
<tr>
<td>Political Navigator</td>
<td>Is aware of political realities, organizational decision makers, formal and informal structures, and power dynamics. Is sensitive to these forces and builds connections that allow for greater influence.</td>
<td>Goleman (1995)</td>
</tr>
<tr>
<td>Resourceful</td>
<td>Assembles, combines, accumulates, and secures the necessary and sometimes rare resources in unique ways and builds long-term capacity through these resources.</td>
<td>Busenitz &amp; Arthurs (2007)</td>
</tr>
<tr>
<td>System Aware</td>
<td>Understands the whole system as well as the different parts, is knowledgeable of the power structures (formal and informal), and sees connections across time. In relation to schools, this also includes awareness of school culture; as Levin (2006) states, “The culture is built on tradition, habit, expectations, and images of what schools should do and be” (p. 22).</td>
<td>Price et al. (2009) Levin (2005)</td>
</tr>
<tr>
<td>Transformative</td>
<td>Disrupts, radically changes, or alters the way education is provided.</td>
<td>Teske &amp; Williamson (2006)</td>
</tr>
</tbody>
</table>
actions and behavior rather than a function of one’s personality. This change in direction resulted in changing the focus of the study from analyzing the competencies of an entrepreneur to focusing on entrepreneurial activity in the setting of schools. Mair and Martí (2006) support entrepreneurship research focused on the activities of the entrepreneur, “Building on a behavioral tradition in entrepreneurship, we argue that examining the set of activities underlying social entrepreneurship as a process may be a more fruitful approach” (p. 38–39).

When the focus changed to the activities teachers David and Faith created beyond the classroom, the new spaces they created for learning as well as the experiential nature of the learning opportunities extended the literature review for the study.
Chapter 3: Methods

Introduction

This research study was conducted within the naturalistic paradigm described by Lincoln and Guba (1985). The naturalistic paradigm, Lincoln and Guba write, includes several axioms, or essential beliefs (p. 37). I conducted this study based on these shared beliefs: within the social world there are multiple realities; the inquirer and the object of the study interact and influence one another; the study is bound by the context of time, place, and situation; the complex nature of the social world makes it impossible to adequately distinguish cause and effect; and the inquiry is influenced by the values of the participants and the researcher. This study features several of the operational characteristics of naturalistic inquiry (Lincoln & Guba):

- I conducted the study in the natural setting of the participants, including the educational settings of the teachers within and outside of the classroom.
- As the researcher, I served as the primary data-gathering instrument.
- I used tacit knowledge since data collection was primarily done through conversation, observation, and human interaction.
- I selected qualitative methods since I was dealing with multiple realities, and these methods lent themselves to the “nature of the transaction between investigator and respondent” (p. 40)
- I used a case study design as it allowed for descriptions and accounted for the multiple realities, values, and local contexts within the study.
- I used a purposeful, rich case selection that identified teachers creating learning opportunities for students beyond their classrooms.
• The design of the study changed and was adapted based on data collection and data analysis.

• I used “special criteria for trustworthiness” that emphasized credibility, transferability, dependability, and confirmability, employing several empirical procedures including member checking, peer debriefing, triangulation, and persistent and varied engagement (p. 42).

As I conducted this research study, the topic was refined and specific research questions emerged from interacting with the different participants, conducting interviews, and analyzing the data. Lincoln and Guba (1985) state, “As the inquiry proceeds, it becomes more and more focused; salient elements begin to emerge, insights grow, and theory begins to be grounded in the data obtained” (p. 209). The major research questions that emerged were these:

1. What actions did these teachers take to build new science learning opportunities for their students?

2. What type of science learning opportunities did these teachers create within and beyond their classrooms?

3. What sustained these teachers to pursue these activities? What forces did these teachers encounter that supported or impeded these activities?

To investigate these questions, a case study approach was used that focused on two teachers and the science learning opportunities they created for their students (Stake, 1995). The aim was for the cases to facilitate “the conveying of experience of actors and stakeholders as well as the experience of studying the case” (Stake, 2005, p. 454). To answer the research questions as well as convey the experiences of the teachers and the students, I used qualitative methods. The remainder of this chapter focuses on the qualitative methods used within this
study. The chapter begins with a brief background of the study and how the cases were selected. For each of the cases, the chapter describes the teacher as a participant, the data sources, and the different settings in which the study took place. The chapter goes on to describe how data were analyzed, including initial analysis, use of narratives, peer reviewing, initial coding, and profile matrices. The chapter then explores the process of establishing trustworthiness, including member checking, triangulation, and peer debriefing. The chapter closes with a conceptualization of the cases and the roles of the researcher.

**Background of the Study and Purposeful Selection**

Initial research began by conducting semi-structured interviews with 9 science teachers participating in a professional development grant entitled EnLiST\(^1\) (see Appendix A for description of grant) and observations of the 14 teachers during EnLiST professional development workshops. As the study unfolded and data were continually analyzed, two teachers, Faith and David, emerged as having pursued activities and created new spaces for students to engage in science education. Those activities were sustained before, during, and after the teachers’ participation in the EnLiST grant. The realization that Faith and David were engaged in activities beyond their classrooms created a unique opportunity to conduct qualitative case studies into their teaching as well as the new spaces in which students were engaging with science education.

In the spring of 2010, when I joined EnLiST, I conducted interviews with teachers in the first cohort who were participating in the grant. Beginning in the fall of 2009, prior to officially joining the grant as a research assistant, interviews were conducted by phone, at restaurants, at

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\(^1\) Partial funding for this research was provided by the Entrepreneurial Leadership in Science Teaching and Learning at University of Illinois at Urbana-Champaign, an NSF MSP (Award Number DRL-0831820). The grant is a partnership between University of Illinois at Urbana-Champaign and school districts throughout the state of Illinois.
schools, and at a library with 9 of the 14 grant participants. In the summer of 2010, I helped plan and then attend a week-long educational session at the UIUC for these science teachers. The aim of the session was to introduce entrepreneurial concepts and have teachers initiate entrepreneurial activities. During this week, I observed these 15 teachers interact with one another and participate in the class activities, I reviewed the in-class work they completed, and I had informal conversations with all of them before class, during breaks, and at the end of the day.

When I conducted interviews with nine high school science teachers who represented all five different districts participating in the grant, I used an interview protocol developed in coordination with the EnLiST research team (Appendix B). To create the protocol, I conducted initial research into the field of entrepreneurship, and this research as well as the input from those who serve on the research team shaped the questions used (see Appendix B). The interviews ranged in time from 40 minutes to an hour. The interviews were conducted face-to-face and were held at an interview location of the teacher’s choosing. Five of the nine interviews took place at the teacher’s school (I visited four of the five participating school districts). The other four interviews were conducted at an offsite location of the teacher’s choosing (see Appendix C). The interviews were recorded with the participant’s permission, transcribed, and uploaded to nVivo.

During the interviews, two teachers provided examples of activities they were leading that focused on science education, took place beyond their classroom, were funded with support from sources outside of the schools, and had spanned more than two years. Based on this initial interview data, I located and reviewed external documents that highlighted their efforts in creating educational opportunities in science. As a result, these two cases became the focus of
the study moving forward. A circle design (Stake, 2010) was created to provide a visual representation of the study.

Figure 3.1 The case study circle design provides an overview of the research questions and a visual conceptualization of this study.

During their participation in the EnLiST grant, David and Faith were the two teachers who were leading projects that connected to the central research questions of the study. David and Faith had initiated educational activities that went beyond the classroom and had operated these activities in difficult, low-income contexts. The desire to focus a study on science teachers who had ongoing activities that went beyond their classrooms was shared with EnLiST co-principal investigator Dr. Fouad Abd-El-Khalick.
While the research began through my role as a research assistant with EnLiST, it extended beyond this role. My role as a research assistant ended in December 2010, and the study continued through October 2012. The study also continued beyond David and Faith’s three-year commitment to the EnLiST program.

Faith’s Case

As I continued with the interviews and observations, Faith emerged as one of the teachers who had created science educational opportunities for students beyond her classroom: a summer science camp for first through eighth graders hosted at two different local community organizations and later on, a science road show at two different elementary schools. In addition to this endeavor, I noticed during observations and interviews that Faith tended to emphasize the role her students have in influencing how she teaches science. During the summer workshop, teachers were asked to draw a diagram of those people who most inform their science teaching. Each teacher began by drawing a circle for him/herself. Next, the teachers were asked to draw circles for those people/organizations that have an important role in their teaching and learning of science. Out of the 15 participants, Faith was one of the only teachers who drew a circle for her students. Faith saw her students as having an important role in influencing how she teaches and learns science. Her science camp that served two community centers as well as her recognition of her students as being central to her teaching and learning of science were what initially drew me to her case.

Faith’s Data Sources and Contexts

Over the course of three years (starting spring 2010 and ending in the spring of 2012), I observed Faith in a variety of different contexts. These contexts included her participation in EnLiST at UIUC, her science classroom, an elementary school gymnasium, the science camps at
the YMCA and Boys and Girls Club, a presentation she gave at a doctoral class at UIUC, and her home as she welcomed me to stay overnight while conducting the science camp research to save on travel time and the expense of an overnight stay. Her welcoming an external researcher to her home provided insight into the hospitality and warmth that she offers to others, and it provided an additional setting to observe Faith.
**Case:** Faith, who creates science learning opportunities through science road shows to elementary schools and two science summer camps

**Timeframe:** January 2010 through May 2012

![Diagram showing contexts and timelines for Faith](image)

**EnLiST Grant January 2010–December 2010**
- Initial interviews (January 2010)
- One-week summer workshop (June 2010)
- One online class session (October 2010)

**December 2010–April 2012**
*Three Science Road Shows*
- Observations
- Informal interviews
- Photographs

**January 2010–May 2010**
*Principles of Engineering and Chemistry Classroom*
- Classroom observations
- Interview
- Document review

**June 2011–July 2011**
*It’s a Small World Nanotechnology Science Camp*
- Observations
- Interviews
- Document review
- Photographs

*Figure 3.2 Contexts and timelines for Faith.*
**Table 3.1**

*Data Sources for Faith*

**Observations (57 hours)**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/20/10–10/21/10</td>
<td>Eastern High School</td>
<td>2 days (12 hours)</td>
</tr>
<tr>
<td>12/3/10</td>
<td>Fall Road Show 2010: Eastern Central Elementary School</td>
<td>3 hours</td>
</tr>
<tr>
<td>4/21/11</td>
<td>Spring Road Show 2011: Eastern Central Elementary School</td>
<td>3 hours</td>
</tr>
<tr>
<td>6/27/11–7/1/11</td>
<td>Eastern, Illinois YMCA Science Camp</td>
<td>5 days (20 hours)</td>
</tr>
<tr>
<td>7/5/11–7/7/11</td>
<td>Eastern, Illinois Boys and Girls Club Science Camp</td>
<td>3 days (15 hours)</td>
</tr>
<tr>
<td>4/17/12</td>
<td>Spring Road Show 2012: Eastern Park Elementary School</td>
<td>4 hours</td>
</tr>
</tbody>
</table>

**Background Observation Data (48 hours)**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/20/10–6/25/10</td>
<td>UIUC: EnLiST Summer Program</td>
<td>5 days (30 hours)</td>
</tr>
<tr>
<td>9/11/10</td>
<td>UIUC: EnLiST Workshop</td>
<td>5 hours</td>
</tr>
<tr>
<td>10/13/10</td>
<td>Live Online Session: EnLiST Workshop</td>
<td>2 hours</td>
</tr>
<tr>
<td>11/13/10</td>
<td>UIUC: EnLiST Presentations</td>
<td>5 hours</td>
</tr>
<tr>
<td>3/19/11</td>
<td>Faith’s Presentation at Doctoral Seminar Course</td>
<td>1 hour</td>
</tr>
<tr>
<td>7/6/11</td>
<td>Faith’s Home: Night Spent with Faith and Her Family During Science Camp</td>
<td>5 hours</td>
</tr>
</tbody>
</table>

**Interviews (8.5 hours)**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/25/10</td>
<td>Eastern High School: Faith’s Classroom</td>
<td>1.5 hours</td>
</tr>
<tr>
<td>10/20/10</td>
<td>Eastern High School: Faith’s Classroom</td>
<td>1 hour</td>
</tr>
<tr>
<td>10/21/10</td>
<td>Eastern High School: Faith’s Classroom</td>
<td>1 hour</td>
</tr>
<tr>
<td>12/3/10</td>
<td>Eastern Elementary School: Gymnasium</td>
<td>30 minutes</td>
</tr>
<tr>
<td>8/5/11</td>
<td>Local Restaurant</td>
<td>2 hours</td>
</tr>
<tr>
<td>8/11/11</td>
<td>Phone Interview</td>
<td>30 minutes</td>
</tr>
<tr>
<td>12/6/11</td>
<td>Phone Interview</td>
<td>30 minutes</td>
</tr>
<tr>
<td>1/14/12</td>
<td>Local Restaurant</td>
<td>1.5 hours</td>
</tr>
</tbody>
</table>

**Archival Data**

<table>
<thead>
<tr>
<th>Type</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newspaper Article</td>
<td>Camp Ignites Engineering Interest</td>
<td>7/13/2007</td>
</tr>
<tr>
<td>Electronic File</td>
<td>YMCA Science Camp Brochure (Transportation)</td>
<td>Summer 2009</td>
</tr>
<tr>
<td>Drawing</td>
<td>Faith’s Social Network Map</td>
<td>6/21/2010</td>
</tr>
<tr>
<td>Newspaper Article</td>
<td>Summer Camp in Eastern Aims to Show Kids That Science Can Be Fun</td>
<td>7/16/2010</td>
</tr>
<tr>
<td>Newspaper Article</td>
<td>Standouts Mix Similar Ingredients</td>
<td>10/15/2010</td>
</tr>
<tr>
<td>Handout</td>
<td>Recorder Daily Report</td>
<td>10/20/2010</td>
</tr>
<tr>
<td>Handout</td>
<td>Review of Classroom Procedures</td>
<td>10/20/2010</td>
</tr>
<tr>
<td>Handout</td>
<td>Compound Machine Design Rubric</td>
<td>10/21/2010</td>
</tr>
<tr>
<td>Electronic File</td>
<td>Faith’s First Day of Class Presentation</td>
<td>11/8/2010</td>
</tr>
</tbody>
</table>

*Given the nature of the archival data used within this case, there was the potential for inclusion of identifiable information. Faith provided informed consent for the inclusion of these sources within the study.*
Table 3.1 (cont.)

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic File</td>
<td>Science Road Show Grant Presentation</td>
<td>11/13/2010</td>
</tr>
<tr>
<td>Digital Photos</td>
<td>Fall Road Show Photographs</td>
<td>12/3/2010</td>
</tr>
<tr>
<td>Newspaper Article</td>
<td>Simple Experiments: Science Show Makes Rounds</td>
<td>12/7/2010</td>
</tr>
<tr>
<td>Brochure</td>
<td>Entrepreneurial Teacher Uses Engaging Experiences Outside the Classroom to Bring Science to Elementary Students (EnLIST Brochure Focusing on Faith’s Road Shows)</td>
<td>Spring 2011</td>
</tr>
<tr>
<td>Electronic File</td>
<td>Application for Science Camp Leader</td>
<td>6/25/2011</td>
</tr>
<tr>
<td>Electronic File</td>
<td>YMCA Science Camp Brochure Write Up (Nanotechnology)</td>
<td>6/25/2011</td>
</tr>
<tr>
<td>Paper Evaluations</td>
<td>High School Leaders’ Nanotechnology Science Camp Evaluations</td>
<td>7/7/2011</td>
</tr>
<tr>
<td>Paper Reflections</td>
<td>High School Leaders’ Camp Reflections</td>
<td>7/14/2011</td>
</tr>
<tr>
<td>Handout</td>
<td>Create a Meal Planning Sheet: Food as Liquid, Gas, and Solid Project</td>
<td>Fall 2011</td>
</tr>
<tr>
<td>Handout</td>
<td>Create a Meal Final Creation Rubric</td>
<td>Fall 2011</td>
</tr>
<tr>
<td>Handout</td>
<td>Create a Meal Peer Grading Rubric</td>
<td>Fall 2011</td>
</tr>
<tr>
<td>Paper Evaluations</td>
<td>Faith’s Chemistry Class Course Evaluations</td>
<td>12/20/2011</td>
</tr>
</tbody>
</table>

David’s Case

When I first became a research assistant with EnLiST, one of the first science teachers I heard about was David. He had started a biodiesel club, had won a large grant of $100,000, was partnering with another high school, had secured donations of time and resources from area businesses, and along with his students, was trying to bring electricity to a Haitian school for the first time using a biodiesel energy source and solar panels. His endeavor had gained the recognition of news outlets, politicians, and his peers. All the while, David was working in a low-income district in a high-crime area of Cook County.

During one of the EnLiST workshops, we asked the 11 science teachers who attended the to identify those projects that they deemed to be the “most entrepreneurial.” All of the teachers selected David’s biodiesel project. The reasons the teachers gave varied, but there was some overlap. The aspects that stood out were the project’s requirement for community involvement, the securing of outside resources, the rallying of people around the project, the changing of how kids think about science, and the active nature of students within the project. It was clear that
others had recognized David and his projects as being entrepreneurial, and his case was one that warranted further time and attention.

**David’s Data Sources and Contexts**

During the three years (starting fall 2009 and ending in spring 2012), I followed David into three different schools. As an untenured teacher, David’s job security was nonexistent. All three of the schools were located within Cook County, Illinois. David was born and raised near the city, and he was openly committed to the city and area schools. In the three different schools, David quickly started and managed large, after-school projects that revolved around green initiatives and alternative energy sources. This case covered a difficult time period for David: losing his job because of reductions in teaching force, looking for new teaching positions, losing his mother, and transitioning to new school contexts. During different times within the case study period and given trying circumstances, David was busy adjusting to new schools and planning for new classes. In order to give David the time and space, I extended the study.
**Case:** David, a non-tenured science teacher, who creates learning opportunities through activities devoted to green initiatives

**Timeframe:** January 2010 through May 2012

---

**EnLiST Grant January 2010-December 2010**
- Initial interviews (January 2010).
- One-week summer workshop (June 2010).
- One online class session (October 2010).

---

**January 2010–May 2010**
*Physics Classroom and Biodiesel Club*
- Classroom observations
- Interview
- Document review

---

**August 2010–May 2011**
*Math Classroom and Eco Club*
- Classroom observations
- Interview
- After-school biodiesel club observation
- Document review

---

**Townsend High School**

---

**Magnet High School**

---

**Riverside High School**

---

**August 2011–May 2012**
*Physics Classroom and Beautification Project*
- Classroom observations
- Interview
- Beautification project observation

---

*Figure 3.3 Contexts and timelines for David.*
### Table 3.2

**Data Sources for David**

#### Observations (31 hours)

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/17/10</td>
<td>Townsend High School</td>
<td>1 day (5 hours)</td>
</tr>
<tr>
<td>12/3/10</td>
<td>Magnet High School</td>
<td>3 hours</td>
</tr>
<tr>
<td>12/3/10</td>
<td>Biodiesel Club at University of Illinois, Chicago</td>
<td>2 hours</td>
</tr>
<tr>
<td>4/23/12</td>
<td>Riverside High School</td>
<td>1 day (7 hours)</td>
</tr>
<tr>
<td>5/11/12</td>
<td>Riverside High School (1/2 School Day and After-School Activity)</td>
<td>1 day (9 hours)</td>
</tr>
<tr>
<td>5/12/12</td>
<td>Riverside Beautification Project</td>
<td>5 hours</td>
</tr>
</tbody>
</table>

#### Background Observations (42 hours)

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/20/10–6/25/10</td>
<td>UIUC: EnLiST Summer Program</td>
<td>5 days (30 hours)</td>
</tr>
<tr>
<td>9/11/10</td>
<td>UIUC: EnLiST Workshop</td>
<td>5 hours</td>
</tr>
<tr>
<td>10/13/10</td>
<td>Live Online Session: EnLiST Workshop</td>
<td>2 hours</td>
</tr>
<tr>
<td>11/13/10</td>
<td>UIUC: EnLiST Presentations</td>
<td>5 hours</td>
</tr>
</tbody>
</table>

#### Interviews (9.5 hours)

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/17/10</td>
<td>Face-to-Face Interview at Townsend High School: David’s Classroom</td>
<td>90 minutes</td>
</tr>
<tr>
<td>6/25/10</td>
<td>Face-to-Face Interview at UIUC EnLiST Workshop</td>
<td>60 minutes</td>
</tr>
<tr>
<td>8/31/10</td>
<td>Phone Interview</td>
<td>30 minutes</td>
</tr>
<tr>
<td>10/14/10</td>
<td>Phone Interview</td>
<td>30 minutes</td>
</tr>
<tr>
<td>12/3/10</td>
<td>Face-to-Face Interview at Magnet School</td>
<td>60 minutes</td>
</tr>
<tr>
<td>4/23/12</td>
<td>Two Face to Face Interviews at Riverside High School</td>
<td>60 minutes</td>
</tr>
<tr>
<td>5/12/12</td>
<td>Face-to-Face Interview Riverside High School</td>
<td>30 minutes</td>
</tr>
<tr>
<td>10/8/12</td>
<td>Local Restaurant</td>
<td>3.5 hours</td>
</tr>
</tbody>
</table>

#### Archival Data

<table>
<thead>
<tr>
<th>Type</th>
<th>Title</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Townsend School Newspaper</td>
<td>Habitat for Humanity</td>
<td>Spring 2008</td>
</tr>
<tr>
<td>Townsend School Newspaper</td>
<td>Townsend Project Wins Lexus Eco Challenge</td>
<td>May 2009</td>
</tr>
<tr>
<td>Townsend School Newspaper</td>
<td>Four Teachers Earn Illinois Directors of Student Activities Awards</td>
<td>May 2009</td>
</tr>
<tr>
<td>Illinois Education Association Web Site</td>
<td>Students’ Project Could Aid Haiti in Many Ways</td>
<td>December 4, 2009</td>
</tr>
<tr>
<td>Online News Article</td>
<td>Ecomacs Earn Award From Governor for Green Project</td>
<td>1/6/2010</td>
</tr>
<tr>
<td>Townsend School Newspaper</td>
<td>Congressman Jackson Applauds Biodiesel Program</td>
<td>1/8/2010</td>
</tr>
<tr>
<td>Online News Article</td>
<td>Operation Haiti: Two High Schools Come Together for Great Cause</td>
<td>1/13/2010</td>
</tr>
</tbody>
</table>

---

3 Given the nature of the archival data used within this case, there was the potential for inclusion of identifiable information. David provided his informed consent for the inclusion of these sources within the study.


<table>
<thead>
<tr>
<th>Table 3.2 (cont.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Townsend School Newspaper</strong></td>
</tr>
<tr>
<td><strong>Club Presentation</strong></td>
</tr>
<tr>
<td><strong>Club Presentation</strong></td>
</tr>
<tr>
<td><strong>YouTube Video</strong></td>
</tr>
<tr>
<td><strong>Townsend School Newspaper</strong></td>
</tr>
<tr>
<td><strong>E-Mail</strong></td>
</tr>
<tr>
<td><strong>E-Mail and Photos</strong></td>
</tr>
<tr>
<td><strong>E-Mail and Photos</strong></td>
</tr>
<tr>
<td><strong>Newspaper Article</strong></td>
</tr>
<tr>
<td><strong>Web Article</strong></td>
</tr>
<tr>
<td><strong>University Article</strong></td>
</tr>
<tr>
<td><strong>Newspaper Article</strong></td>
</tr>
<tr>
<td><strong>E-mail</strong></td>
</tr>
<tr>
<td><strong>Web Article</strong></td>
</tr>
<tr>
<td><strong>Brochure</strong></td>
</tr>
<tr>
<td><strong>Brochure</strong></td>
</tr>
<tr>
<td><strong>Web Site</strong></td>
</tr>
<tr>
<td><strong>Magnet School Newspaper Article</strong></td>
</tr>
<tr>
<td><strong>University Article</strong></td>
</tr>
<tr>
<td><strong>Newspaper Article</strong></td>
</tr>
<tr>
<td><strong>National Education Association Web Site</strong></td>
</tr>
<tr>
<td><strong>E-mail</strong></td>
</tr>
<tr>
<td><strong>E-mail</strong></td>
</tr>
<tr>
<td><strong>Magnet School Web Site</strong></td>
</tr>
</tbody>
</table>

**Data Analysis**

This section of the chapter is focused on the data analysis, including creating contact summary sheets after interviews and observations, coding transcripts of interviews and field notes, writing memos, developing interim reports, and collaborating with peer reviewers.

**Data analysis of interviews and observations.** During the interviews, I used a conversational interview approach and asked follow-up questions based on the teachers’
responses (Charmez, 2006). Open-ended questions were used, and teachers were encouraged to incorporate their experiences. After each of the interviews, contact summary sheets were created (see Appendix E for an example) (Miles & Huberman, 1984). During the interviews, I listened carefully to the language of the teachers and incorporated their language when asking follow-up questions (Charmez, 2006, p. 35). Thus, the stories shared by the teachers shaped subsequent questions, interviews, and observations.

The study included two types of observations. The first occurred in the classrooms and schools in which David and Faith taught. During these observations, field notes were taken and documents were collected. Archival documents included school newspapers, classroom handouts, classroom assignments, and PowerPoint presentations. During the school and classroom observations, I served as a nonparticipant-observer. The second type occurred while observing Faith and David during the EnLiST workshops where I served as a participant-observer (Lincoln & Guba, 1985). As a research assistant, I helped coordinate the workshops, prepared materials, and at times provided insight during the workshops. Regardless of my role, I took field notes during all observations and then transcribed them. I tried to capture comments shared by all participants as well as describe the setting and environment. An example of partial field notes that were typed up based on a conversation from an EnLiST workshop is included in Appendix F.

Data collection and analysis happened simultaneously and were woven together (Glaser & Strauss, 1967; Miles & Huberman, 1984). After the first round of interviews, the transcribed interview data were uploaded to nVivo. In addition, contact summary sheets that included a brief description of each interview and initial thoughts based on the interview were created. All field notes, documents, and observations have been organized and reviewed. After reviewing the
data collected, I generated more questions for further exploration and returned to the participants to inquire further. The data collection and analysis became a cyclical process.

I conducted an initial analysis while uploading and reviewing the interview data from the nine teachers. I realized that two teachers had taken entrepreneurial actions to create learning experiences for their students outside of school, and that the issues emerging from their experiences warranted further investigation. To explore these emerging issues, I drafted data memos based upon the data (see Appendix G) (Corbin & Strauss, 2008). These memos provided initial codes based on the data. In addition, four interim reports were sent to dissertation advisor Liora Bresler (see Appendix I).

**Coding the data.** Data were transcribed, including the narratives, field notes, and interviews, and coded using an initial coding technique (Charmez, 2006). The following table provides an excerpt from an interview that demonstrates the coding process used.

**Table 3.3**

*Examples of Initial Coding of Interview Transcript*

<table>
<thead>
<tr>
<th>Initial Coding</th>
<th>Interview with David</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching as performing and entertaining</td>
<td>First, it has to do with being a little bit of an entertainer and as a teacher. I've got to be interesting, knowledgeable, funny, and witty; kids don’t like teachers that are boring, period. I don’t care what subject, even if you like science, so a little bit of it has to do with just your overall presentation, how you come out.</td>
</tr>
<tr>
<td>Being knowledgeable and funny</td>
<td>The next thing is you kind of deemphasize being wrong; I do in my class. Everybody is going to be wrong a lot in my class; it’s okay to be wrong, just learn from your mistakes. Like on their homework they get multiple tries, like seven tries on what I’ve assigned, so you can get it wrong seven times, but between the first and last try they could ask for help, so they know they can get it right if they just keep digging. I build that into their character to just keep going at it and you’ll get it right and then you’ll be prepared.</td>
</tr>
<tr>
<td>Valuing the presentation of the subject</td>
<td></td>
</tr>
<tr>
<td>Providing space for student mistakes</td>
<td></td>
</tr>
<tr>
<td>Learning from mistakes</td>
<td></td>
</tr>
<tr>
<td>Watching for student growth through process of doing science</td>
<td></td>
</tr>
<tr>
<td>Emphasizing multiple tries as part of learning process</td>
<td></td>
</tr>
</tbody>
</table>
In addition to initial coding, a profile matrix was created that incorporated the research questions established for the study (Bernard & Ryan, 2010). The profile matrix provides the different attributes that were identified within both cases.

Table 3.4

Faith and David Case Profile Matrix

<table>
<thead>
<tr>
<th></th>
<th>Faith</th>
<th>David</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opportunity Creation</strong></td>
<td>1. Creates active student exploration of science concepts</td>
<td>1. Infuses prior professional background within teaching</td>
</tr>
<tr>
<td></td>
<td>2. Collaborates with community organizations and university partners</td>
<td>2. Is enterprising and resourceful</td>
</tr>
<tr>
<td></td>
<td>3. Connects science to everyday life</td>
<td>3. Seeks real-world problems for central focus</td>
</tr>
<tr>
<td></td>
<td>4. Blends opportunities within current structures and institutions</td>
<td>4. Has an unwavering focus on vision</td>
</tr>
<tr>
<td><strong>Student Interaction</strong></td>
<td>1. Integrates high school students as mentors and leaders</td>
<td>1. Animates students to teach others and lead</td>
</tr>
<tr>
<td></td>
<td>2. Values student feedback</td>
<td>2. Propels students to consider educational future</td>
</tr>
<tr>
<td></td>
<td>3. Involves students in planning and implementation</td>
<td>3. Cares for students and uses humor</td>
</tr>
<tr>
<td></td>
<td>4. Provides space for experimentation</td>
<td>4. Keeps students actively engaged</td>
</tr>
<tr>
<td></td>
<td>5. Solicits and rewards those who volunteer</td>
<td>5. Provides space for open dialogue and new experiences</td>
</tr>
<tr>
<td><strong>Obstacles to Opportunity Creation and Growth</strong></td>
<td>1. Lacks time to devote to creating new spaces for learning</td>
<td>1. Without tenure, lacks peer and administrative support</td>
</tr>
<tr>
<td></td>
<td>2. Lacks people and support from within district to grow the experiences,</td>
<td>2. Navigates the cycles of urban schools’ reductions in teaching force</td>
</tr>
</tbody>
</table>

**Incorporating peer review into data analysis.** Based on the data collected, I created narratives for both cases (Wolcott, 2009). I solicited peer reviewers who had been high school science teachers and who were now science education scholars. Two reviewers were PhD candidates in curriculum and instruction with an emphasis in science at UIUC. One was a former science teacher who was a PhD candidate in educational psychology. The forth reviewer was a post-doctoral researcher at University of Illinois who had completed a PhD in educational psychology at the University of Wisconsin–Madison. The reviewers read the narratives and provided issues and themes they identified within the narratives as being particularly compelling.
when it comes to science teaching. After their review of the narratives, I conducted two face-to-face meetings with the reviewers to discuss the narratives and determine which parts resonated with their background in science teaching and science education research. The following table provides summarized sample comments that informed ongoing drafts and conceptualizations while working through the data analysis phase.

Table 3.5

Sample Peer Review Comments

<table>
<thead>
<tr>
<th>Reviewer</th>
<th>General Comments Based on Case Narratives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randy</td>
<td>David and Faith view their responsibility for teaching science differently than other science teachers. They view their responsibility as “being above and beyond the typical teacher.” It appears that their “notion of what a teacher should be doing” might be different than that of other teachers. Randy contrasts David and Faith to teachers who went into teaching for the hours and summer vacation. The summer-off view of what is involved in being a teacher stands in stark contrast to Faith and David. In both cases, it is difficult to draw conclusions about the teachers’ views on the nature of science. There is enough to distinguish how these two teachers view science: Faith as inquiry and doing science; David as engineering and building with science.</td>
</tr>
<tr>
<td>Jacob</td>
<td>David moves beyond the textbook with the opportunities he creates and brings in societal problem solving issues that are so new that they aren’t covered in textbooks. David is enveloping “green” initiatives in a way that goes beyond what the textbooks do. Faith takes textbook learning and makes it experiential. The activities that she creates bring the textbook to life, but she does not move too far beyond the standard science curriculum. Rather, she provides active student experiences related to the curriculum.</td>
</tr>
<tr>
<td>Gina</td>
<td>The narrative includes examples of these teachers using a lot of “hands-on learning activities,” but the cases are limited in being able to title the learning as “inquiry-based.”</td>
</tr>
<tr>
<td>Erica</td>
<td>David’s approach to science seems to be rooted in his “engineering background.” He sees science to be project based and incorporates the design, build, test cycle in his teaching. He is good at bringing in “private sector” science into the classroom, and Erica feels this is quite rare. David’s approach does connect with the new “next generation science standards.” He clearly values “real-world” product development that connects to problems. Faith’s approach to science teaching is rooted in her (Faith’s) own description of how she learns science through discovery and inquiry. Faith is comfortable moving to the back and letting her students assume the lead which is important in inquiry-based learning.</td>
</tr>
</tbody>
</table>

During the discussion with the reviewers, several themes emerged as being salient.

Through the opportunities provided by Faith and David that went beyond the classroom, students gained more exposure to science. The experiences did seem to require the students to be actively involved with science experiences; however, there was limited evidence to label the experiences
as experiential or inquiry based. Through the review of the cases, they indicated that Faith and David were resourceful in identifying people, grants, and suppliers for bringing these activities to fruition. David seemed more targeted at writing large-scale grants, and Faith seemed more accomplished developing a relationship network within the community to support her efforts. They commented that both had a vision they wanted to accomplish, and they were able to develop shared goals with their students. Both Faith and David seemed to have a tolerance for going against the grain. They didn’t seem concerned with the consequences of doing something beyond the status quo and moved forward even when they know there will be difficulty.

A critical dynamic that all pointed out was that Faith and David have strong backgrounds in science. They majored in a scientific subject, obtained traditional certification, and continue their own learning in science. The reviewers believed this was essential to Faith’s and David’s ability to confidently create these learning opportunities and that it provided the ability to work through struggles.

**Establishing Trustworthiness**

To establish the trustworthiness of data, several approaches were used in the study. These include member checking, triangulation, peer debriefing, persistent observation, and prolonged engagement (Lincoln & Guba, 1985). In addition, a new approach was used: participant presentation that coincided with a peer debriefing. To help illustrate each of these concepts in relation to the study, examples are provided here.

**Member checking.** As data was collected, I provided participants with the option of reviewing the transcripts. Once case studies were drafted, I asked not only for feedback from Faith and David but also for additional information that they felt would be worth adding or would help clarify any points. With Faith’s case study, I sent the case study to her. She not only
provided feedback, but she also offered additional details. After Faith’s review of the case, she provided further clarification and information regarding how she formed a connection with the elementary school principal that came to support her Science Road Show. This process of member checking allowed for the case to be reviewed for accuracy, provided more accurate and rich data, and led to avenues for the case to be expanded and refined. David read through the case and clarified how he decided to become a teacher. He started his master’s degree in engineering, and it was through a teaching assistant position during pursuit of his graduate degree that led to him deciding to pursue a teaching certificate. This was an important distinction and clarification.

**Triangulation.** During observations and on-site interviews with Faith and David, I had opportunities to talk with students, teachers, and administrators. During my conversations with others in the study, I inquired about information that was emerging during the observations and interviews. By exploring facts and concepts that were in the interviews and observations, I was able to triangulate the data. In order to gain confidence in the quality of the data, I attempted to “look and listen from more than one vantage point” (Stake, 2010). I reviewed documents such as local newspapers, school newspapers, and participant materials, and the document analysis provided support for the projects created by the teachers and confirmed their actions. In Faith’s case, her teacher colleagues, science road show students, and the local newspaper were all used in conjunction with her interviews and observations to provide support for how she managed the summer science camps. During one interview, Faith indicated students and the teachers who help during the summer take on leadership roles and shape the camp’s activities. When talking with Faith’s fellow teachers and her students, they explained that Faith had them take the lead and create new activities for the camp. Her perception of having students serve as leaders at the
camp was triangulated with the perceptions of fellow teachers, high school students participating at the camp, and the directors at the two community centers.

**Peer debriefing.** I presented the research as a work in progress to the EnLiST research team and to fellow graduate students in three different Fat Data sessions hosted by my dissertation advisor, Liora Bresler (see Appendix H). During the peer debriefing sessions, I took detailed notes that were used to reflect and refine ongoing data collection, analysis, and writing. During one peer debriefing session, a fellow doctoral student who was a former science teacher reviewed an excerpt of the case study of Faith and indicated that she didn’t see anything “unique,” and that Faith’s teaching mirrored her personal experiences. During the discussion, I was able to provide additional excerpts from the observation data. This doctoral peer identified that the activity in which Faith provided students the opportunity to build, destroy, and rebuild a simple machine was an example from Faith’s teaching that she would consider unique to the science classroom and more indicative of inquiry-based learning. Because of my limitations working within the science classroom, this student’s perspective helped identify incidents from observations that warranted further attention.

Recognizing I did not have a background in science education, I sent the two case studies to a fellow doctoral student in science education and a science education postdoctoral researcher at the UIUC. Their insights were used to further analyze the data and connect the cases to existing literature in science education.

I also shared the initial case study of Faith with a doctoral-level course on academic entrepreneurship. In addition to their peer debriefing, Faith came and presented to the class about pursuing educational entrepreneurial activity. She was invited to join the class and gave permission for my draft case study of her and her presentation to be combined during a class
session. Peer feedback on the case study and Faith’s presentation provided insightful perspectives on how to further refine the case to reflect Faith’s presence in the classroom. After reviewing the case study of Faith, the doctoral students had expected her to be quiet and more reserved. After Faith presented to this class of doctoral students, the students commented that Faith had more dynamic qualities and was more animated than expected. The importance of peer debriefing as well as the unique opportunity to couple this process with a participant presentation allowed for the case study of Faith to be further developed and to come closer to capturing the essence of who the participant is as a teacher.

**Varied engagement.** When it comes to qualitative research, the term *prolonged engagement* is often used. This term is connected to a sufficient amount of “time” devoted to achieve the purpose of a study (Lincoln & Guba, 1985). This study took a different approach in using what I will call *varied engagement*. This study began in January 2010 with data collection ending in October 2012. The importance of following these teachers into different settings was highly relevant to the research questions. Much of prior educational research is confined to one particular site, the school or classroom, for a prolonged period of time. Because this research went beyond the teachers’ classrooms and into their communities, a varied engagement strategy was used. For instance, David’s journey over these three years has included facing three different reductions in the teaching force at three different high schools and the associated activities he had created. Faith conducted science learning activities in her classroom, at three different elementary schools, and at two different community centers. In addition, the research included observations of Faith and David with teachers engaged with peers during the EnLiST workshops.
Conceptualizing the Cases

To explore the cases using an entrepreneurial lens, the following conceptual map was developed to help shape the study and answer the research questions. This included looking at the actions taken by the teachers, the new science learning opportunities that they created, and the areas of support used to develop new spaces for science learning. The culture and context of low-income schools was a background that remained throughout both cases.

Figure 3.4  A visual conceptualization of the three research questions with the context of low-income, public schools.

Roles of the Researcher

Non-science educator. I am not a science educator. I was a high school English teacher who left the classroom after four years and spent seven years in corporate America prior to...
pursuing my PhD. As a high school student who did well in math, I somehow found my way into upper-level science classes. I tolerated science; read the textbook; took the tests; earned a solid B; and never once considered biology, chemistry, or physics as viable or interesting pathways for future study. My disinterest might have been connected to the number of dissections I completed during my freshman year biology courses (grasshopper, cow’s eye, frog, and pig). Or, it could have been that I viewed science as a tedious practice in memorization: name the bones of the body, list the parts of a plant, provide the elements in the periodic table, recite formulas, and so on. I came to this research in science education in the same way most students come into the science classroom: disinterested and unengaged in science. My own experience with science education and overall lack of interest seemed to mirror that of many students cited in the 2006 PISA report (PISA).

When I interviewed the nine science teachers, I was intrigued by the two science teachers who created learning opportunities in the sciences that went beyond the classroom. I was drawn to those teachers who had created opportunities that seemed to pique student interests in learning science. In Faith’s case, I observed her working with students in a variety of contexts, watching how Faith facilitated these experiences and how she built learning opportunities beyond her classroom. I spent time in her classroom, observed three different Science Road Shows at two different elementary schools, and attended the summer science camps at two different community centers. With my own children, I found myself showing them the different experiments and talking about the scientific concepts that I was learning from Faith’s students. I went online and found websites that gave me more experiments to try, went to the bookstore and purchased books about chemical reactions, and realized that my own interest was growing as a result of being involved with this case. When it came to David’s case, I found myself doing the
calculations that students were doing in class. I drew the diagrams he put on the board; inspired by how he challenged students to look into their futures, I imagined myself as an engineer, a thought that had never once crossed my mind prior to researching the case. Just as the students were becoming more engaged with science through their classrooms and entrepreneurial activities, I too felt my own interest in science growing.

**Active observer: Moving in closer.** As part of the research, I found myself moving beyond the traditional role of observer and researcher to becoming an active participant within the contexts of these science learning opportunities. During the observations of the entrepreneurial activities, it became natural for me to help get supplies ready, clean up after the event, and talk with the students about their lives beyond the activities. I became engaged in Faith’s and David’s entrepreneurial activities just as those around them did the same. It was a natural progression of moving in closer to learn more while also taking an active interest in those who were in the case.

**Research assistant to independent researcher.** When the study began, I was serving as a research assistant. The grant participants viewed me as someone working with and for the grant. They often sent me questions about upcoming events and saw me as someone helping with the entrepreneurial education segment of the grant. This role of being someone within the grant brought the opportunity to get to know the grant participants more and in different settings, but it also meant that they clearly connected my research with the education they received. Once my time with the grant ended, I continued my research more independently. Faith and David recognized that this study, while rooted in the grant, went beyond it. The relationships established through and with the grant carried over.
Chapter 4: Creating Spaces for Science Discovery

Introduction to Chapters Four and Five

Chapters 4 and 5 share similar structures as they focus on Faith and David, the key participants within the case studies, who are creating educational opportunities for their students beyond their classrooms. Faith’s and David’s ability to bring science content learning into the community highlights how they created new spaces for learning science in resource-lean settings. Chapters 4 and 5 are organized around central themes shared by both cases: (a) the creation of learning opportunities that extend beyond the classroom, incorporate school science, and happen in low-income settings; (b) the background of the teachers and the connections to the learning they create; (c) the experiential learning activities used within the classroom that then carry beyond the classroom; and (d) the curriculum constraints, bureaucracy, and structures of schooling and the implications for extending science education beyond the classroom. To illustrate key issues within the different chapter sections, I have included vignettes. Prior to each vignette, I provide a conceptual framing that highlights the central issues within the vignette. In addition, the narrative style of the vignettes provides avenues for readers to bring additional interpretations and identify other issues that are pertinent to the case.

School Science Learning Beyond the Classroom: Building Science Summer Camps

Faith created learning opportunities for students in her classroom, outside of her classroom but within the school district, and beyond the school district. The summer science camp is where the chapter begins; it also includes her work to bring science road shows to two elementary schools within her district and the experiential learning experiences within her classroom.
Creating a summer science camp at local community centers. This chapter opens with a vignette highlighting the science learning opportunity Faith developed beyond her classroom and in conjunction with two area community centers. Faith’s summer science camp was located in Eastern, Illinois, and was in its sixth year. During those six years, Faith raised over $50,000, served over 100 K–8 students each summer, hired and employed eight high school mentors to lead the camp, and retained approximately 70%–80% of campers from year to year. The science camp curriculum was devoted to scientific exploration tied to thematic science concepts selected by Faith, incorporated reform-minded science activities selected by Faith and her staff, and was actively led by the high school leaders. Faith used an application process to hire the eight high school leaders, paying them $8 an hour. She also hired a fellow high school science teacher to serve as the camp’s co-director.

Faith’s summer science camps were operated separate from the community centers’ traditional programming. Student attendance at the camp was strictly voluntary for students enrolled in the community day center programming. Because of the funds Faith raised to operate the camp, there was no added expense for the community center students who chose to enroll. The camp was at full enrollment, 50 students at each camp, and had been for the last few years. The following vignette introduces several issues at work in the science camp: the context of Eastern, the design of multi-age level learning, the summer employment and mentoring through science, and school science being brought to where young people are in the summer.

Vignette 4.1: Introduction to science camp, Eastern, Illinois, June 27, 2011, 8 a.m.

Today marked the first day of Faith’s 2011 Summer Science Camp located in Eastern, Illinois. Eastern’s population was just over 30,000 and was facing economic challenges that spanned over the last 30 years. On a drive through town, large, abandoned industrial buildings dotted
the town’s landscape. One abandoned building spanned two city blocks. An enormous parking lot surrounded this huge, defunct manufacturing plant, and there was not a car to be found. The small security office where employees once signed in to start their workdays was nearly collapsed, the grass and weeds had reclaimed the concrete, and the rusting exterior of the building was beginning to cave in. Those parking spaces were once filled with cars, and the gainfully employed, lunchboxes and thermoses in hand, would have moved in shifts toward the building. Now, those jobs were eerily gone, and this building served as a physical reminder of the city’s defunct labor market. The nearest large city was 90 miles to the east. When jobs were lost in Eastern, people moved, leaving Eastern behind. Eastern’s historical population data showed the growth and decline of the town. The town began to boom in 1910 and continued to grow until 1970. Since 1970, as shown in the Decennial U.S. Census, the population and the economy of Eastern had seen significant decline. In 1970 the population peaked at 42,570 and then swiftly began its decline. The population as of the 2010 Census was 33,027; this was a 22% drop in population over the last 40 years (U.S. Census Bureau, 2010).

Several railroad tracks snaked through the town, converging in a large industrial area. Eastern, because of its salt deposits and coal, served as a mining town for many years, but the mining industry began its decline here in the 1940s. Several manufacturing plants remained open, and the trains still made their way through town and stopped traffic as they carried goods to and from the plants; however, the trains and manufacturing plants were a small fraction of what they had been when Eastern was a thriving industrial town. The poverty data provided by the Census provided more information about Eastern’s economic difficulties. As of 2009, the
percentage of all people living in poverty in Eastern was 26.7%. The percentage is over double that of the state average at 12.4% (U.S. Census Bureau, 2010). Because Eastern’s poverty average was more than 50% higher than the state average, the city was considered to be at a critical poverty level.

Situated close to the industrial side of town were neighborhoods that must have flourished in the 1950s. Now, these neighborhoods struggled to survive. There were sporadic empty lots where homes once sat, but because of abandonment, decay, or fire, these lots were empty. Other homes were dilapidated with boards covering the windows. At one home with boarded windows, the sun-bleached toys in the front yard indicated a family still lived there. The sidewalks that connected these houses and led to the old neighborhood school were cracked, broken, and covered with grass. The poverty rate wasn’t just reflected in the Census numbers and statistics; it permeated many parts of this community and was plainly visible. After a drive through town, I made my way to the Eastern Young Men’s Christian Association (YMCA) where a summer program was offered to school age children and served as the location for the first week of summer science camp.

YMCA, Eastern, Illinois, June 27, 2011, 8:45 a.m. Eight high school students were setting up science stations at long tables that lined the perimeter of a multipurpose room in the Eastern Illinois YMCA. These high school students were selected to lead the first of two different summer science camps for elementary and middle school students. The first camp was offered

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4 “Following the Office of Management and Budget's (OMB) Statistical Policy Directive 14, the Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically, but they are updated for inflation using Consumer Price Index (CPI-U). The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps).” (U.S. Census Bureau http://www.census.gov/hhes/www/poverty/about/overview/measure.html)
here and the second camp was offered at the Boys and Girls Club. These one-week, summer science camps were created by Faith, and this was her sixth year leading the camps in Eastern.

The high school students, worked in pairs, collected and checked off the needed supplies from their daily science activity sheets. Tim, Faith’s co-director for the camp, prepared the projector and laptop at the front of the room. Faith moved from pair to pair answering questions from the high school leaders.

The door to the multipurpose room opened. A group of students who had finished first through third grade came into the room. Their colorful name badges hung loosely around their necks. A small boy with well-worn shoes spun his badge quickly so that it wound around his two fingers; he then spun it in the opposite direction and wound it the other way. He looked around the room purposefully, and he walked quickly up to Faith, adding a slight skip in his step. He stood close to her small frame and peered up at her. She was talking with two of the high school students, but she sensed his closeness and turned to face him. His energy carried him through a series of questions and statements. He left little room for response: “Is this science camp? I love science camp. I can’t wait. What are we gonna do? Do we get to take stuff home like last year?”

Faith bent her knees slightly so rather than him looking up at her, he now had her direct eye contact. “Yes, this is science camp. We are going to learn about nanotechnology. We have a lot of fun experiments. Go have a seat, and I will tell you more in a few minutes.” He rushed to a chair, and as his body landed on the seat, the chair skidded back slightly. The YMCA counselor who was dropping off the campers called after him, “Slow down! Be sure to behave yourself.” He didn’t turn or acknowledge the directives. He joined the other campers in chairs that neatly lined the center of the room.
The 21 campers faced forward, and their small feet dangled from the hodge-podge collection of adult-size chairs: orange plastic, dingy-yellow plastic, vinyl black upholstered with stuffing hanging out the side. The students' legs moved back and forth at varying speeds stirring up energy in the room. There were 14 girls and 7 boys. The students were predominantly white and came from working-class families who resided on the west side of Eastern. While most of the students attended Eastern public schools, a few of the students came into the YMCA day camp program from the rural outlining areas of the city. The camp director later explained that the vast majority of campers qualified for free and reduced lunches at their public schools.

As the students sat in their chairs, Faith’s co-director, Tim, used a permanent marker to put a small black dot on each of the campers’ hands. Faith moved to the front of the room and welcomed them to science camp. Faith was wearing a bright, neon green t-shirt from a prior year’s camp. Throughout the week, she would wear a different science camp shirt each day. They were all brightly colored and emblazoned with the camp’s theme. At the end of the week, these campers took home their own free science camp t-shirt. Faith created the t-shirts to help the students remember the experience and theme of the camp. Some of the campers, like Faith, would wear prior year’s t-shirts to camp.

The students watched Faith as she stepped closer to their seats. She asked how many came to camp last year, and 15 of the 21 hands are raised. She asked students to share what they remembered from the last science camp. A young girl raised her hand and spoke as soon as Faith looked in her direction, “We solved the case of the missing cookies.” Another boy volunteered but hesitated as he said, “We used furr-ehn.” Another student helped out, “Forensics!” Faith nodded and brought her hands together gently in appreciation of their memories. “That’s right!” One camper shared the whole missing cookie story including who
was the final culprit who nabbed the cookies and how they used evidence to solve the case.

Faith moved on to introduce this year’s science camp theme. “This year’s camp is called, ‘It’s a Small World.’ We are going to talk about something called nanotechnology.” Her voice was intense, bright and each word had emphasis; there was a rhythm when she talked, and the students’ eyes were on her.

When talking one-on-one or in a group setting, Faith was an intense listener. When sitting among a group of her teaching peers in a workshop setting, she was quiet and thoughtful, and her eyes focused in on each person as they talked. She didn’t command others’ attention in the same manner as she was doing in front of these elementary students; rather, she gave her attention to others. She displayed a different dynamic. She talked with a purpose and passion, and the students’ eyes fixated on her as she spoke. She continued to be an avid listener: When each of the students offered up an answer, she moved close to the student speaking, and the student had her full attention.

“Nanotechnology,” Faith said again. She had the students repeat the word, and they responded in unison, “Nanotechnology.”

“We are going to study things that are really small. Take a look at the dot on your hand. Can you think of other things that are really small?” The answers varied and emerged from the students like pieces of popcorn popping into the air: “a grain of sand,” “a pebble,” “a piece of rice,” “sugar,” “a baby’s tooth.” Faith acknowledged each response by making eye contact, nodding, offering affirmation. She transitioned, “We are going to work in small groups with these high school leaders to learn more about nanotechnology. We are going to look and work with things that are really small.”
Prior to breaking the campers into their small groups, she asked each of the high school students to introduce themselves. Immediately after the introductions, Faith also provided some safety tips by having two high school leaders demonstrate the importance of goggles.

She divided the campers into small groups of five or six campers and had them report to one of the stations. These high school leaders served as their small group’s leader for the remainder of the week. The campers moved quickly to their assigned stations. Two male campers struggled over who would get to sit next to one of the male high school leaders, Steve. Both students had firmly planted themselves upon the chair next to Steve, and they elbowed one another attempting to gain ownership over the space. Without hesitation, Steve pulled an extra chair to the other side of him, and the struggle ended. The boy closest to Steve moved to his other side, and they now each had a chair next to Steve.

On a typical summer day, these campers did not spend their mornings in this multipurpose room. Their morning schedule included time in the gym to play basketball or other games, swimming, creating crafts, and for some, spending a little time on the computer. The time spent at the YMCA was predominantly recreational and dedicated to promoting a safe place for kids in the summer. Little emphasis was placed on academic programs. For the next week, the students blended recreation with science through the summer science camp.

Identifying an opportunity: The history of Faith’s summer science camp. The previous vignette highlights the first day of Faith’s summer science camp, a camp that began over nine years ago in a different city. Prior to moving to Eastern, Faith had created a successful summer camp in the rural community in which she taught. When her children were elementary-school age, Faith realized there were limited opportunities for younger students to engage in learning activities during the summer months and particularly in the rural community where they
lived. One of the programs her own children enjoyed was closing. This summer-long program was sponsored by University of Illinois; it was called the Illinois Rural Recreation Development Project (IRRDP) and was funded by the W. K. Kellogg Foundation. The grant funding was coming to an end, and the program would no longer be able to operate. The IRRDP moved around to different rural communities and featured theme weeks. Faith was invited to participate in the science week by doing demonstrations on one of the days. She traveled to different cities, taking her own children along, and doing the demonstrations. When Faith learned that IRRDP had lost its funding source and would no longer be offering the summer program, she saw the critical gap it would leave in summer learning opportunities in her rural community. She also noticed when traveling to different communities that the school-age children expressed a common theme: an aversion to science. Faith hoped, through a dedicated summer science camp, she could change young students’ experiences with science, increase their fascination and curiosity for learning science, and also meet the demand for a summer program:

\textit{I wanted to see it (the camp) continue and then I—I just cringe when students say “science isn’t fun; it’s boring.” Well, they’re in the books; there is no hands-on going on, so let’s provide a situation to make it more exciting and fun. Provide opportunities for high school students to be employed and to work with the younger kids and then also for kids to see that science is a hands-on situation and it can be a lot of fun.}

Inspired to make science more engaging, exploratory, and approachable for a younger audience while also being motivated to offer a learning opportunity for kids in the summer, Faith proposed offering an independent science camp. Working with the town’s parks and recreation program, Faith received approval to host the camp, and she subsequently secured funding for the
camp through a large, local chemical company. After creating and leading three successful summers of science camps between 2003 and 2005, Faith and her family relocated to Eastern in 2005. Once Faith had settled in at Eastern and her job as a high school science teacher, she realized the need for a summer science camp extended to Eastern as well. Rather than build a separate science camp program, Faith recognized an opportunity to offer the science camp as a supplemental summer program to the full-day summer camps already being offered by two area community centers for students K–8. When Faith reached out to both community centers, they were extremely receptive to her proposal of a science camp in which the elementary age students were actively engaged with science concepts, the camp would be led by high school students, and the camp would be directed by area high school science teachers. In the summer of 2006, Faith directed Eastern’s first summer science camp offered through the YMCA. Prior to Faith’s arrival in Eastern, these science camps were not features of the summer curriculum at either community center.

The Boys and Girls Club was the location for the second week of Faith’s science camp. The demographics of the YMCA and the Boys and Girls Club shared similarities and difference. Like the YMCA, the majority of children attending the Boys and Girls Club summer programming came from families who were identified as low income and received free and reduced lunches at their schools. At the YMCA summer science camp, 80% identified as Caucasian, 8% as Hispanic, 8% as African-American, and 4% as Mixed. At the Boys and Girls Club summer science camp, 95% identified as African American, 3% as Mixed, and 2% as Caucasian. The camps were both almost equal when it came to gender. There were slightly

5 In 2006, 51% of school-aged children with working mothers spent the summer in some form of regular childcare (organized care, nonrelative, or relative) (U.S. Census Bureau, 2010).
more girls in the first through third grade groups and slightly more boys in the fourth through eighth grade groups at both camps.

The Boys and Girls Club building was located on the other side of Eastern and was in the city’s most economically distressed area. The Boys and Girls Club had been active in Eastern since 1989. In 2003 the club built a new building in this neighborhood. The building included a gym; computer lab; cafeteria; teen room; youth room; art room; and recreation room with a ping-pong table, air hockey, and foosball table. The Boys and Girls Club focused on youth, and its mission was “to inspire and enable all young people, especially those who need us most, to reach their full potential as productive, caring and responsible citizens.”

Similar to the YMCA, the Boys and Girls Club summer camp provided full-day programming for students. Parents had the option of dropping students off as early as 7:45 a.m. and picking them up as late as 6 p.m. All summer programming at the Boys and Girls Club was centered on the following areas: education and career development; character and leadership development; health and life skills; sports, fitness, and recreation; and arts. Frank, the club’s director, explained the summer programming varied from year to year based on who volunteered to lead. The science camp, he said, was the one camp that had been consistently offered over the years. Frank told me the science camp was a favorite among Boys and Girls Club members. “Every summer, students ask about the camps. They aren’t asking me about the baseball camp; they are asking me about the science camp.” He said, “It’s a popular camp, and they enjoy it. It’s hands-on, and they do experiments. We don’t focus much on science in our academic programs; we mainly focus on math, reading, and computers. It is good that she [Faith] comes back year after year. Even our teens sign up for it, and it’s hard to find academic programs that get them interested.”
In both the rural setting and in Eastern, Faith identified a need for students to be engaged in science learning during the summer. She recognized an opportunity in Eastern to partner with organizations where a large number of students were spending their summer months: at local community centers. Along with recognizing the need, she was able to establish a science learning experience that students sought out. There was student- and parent-generated demand for the summer science camp. The project directors at both the YMCA and Boys and Girls Club counted on Faith to continue offering the program, and it was the parent and student feedback that provided the necessary incentives for Faith to create new science learning content and activities each summer.

**Creating mentoring and employment opportunities for high school students.** An important element of the camp, for Faith, was the opportunities it provided for the high school students. She said, “I want to provide the high school leaders an experience where they can teach younger kids science and also give them the opportunity to work.” Of the eight high school students working as science camp leaders this summer, six were female and two were male. The students self identified as follows: 1 African American; 1 Asian; 1 Mixed (African American and White); 1 Hispanic American; and 4 White. Through funds that Faith generated from grants and donations for the camp, these students were paid science camp mentors. When Faith asked them to introduce themselves to the campers, their interests and descriptions of themselves varied, but each description closely connected to the activities they most enjoy. They are “a singer,” “a serious gamer” (a love for videogames), “a guitar player,” “a tennis player,” “a swimmer,” “a cheerleader,” and “a builder” (a love for building model airplanes, cars, etc.). In addition to the high school leaders, Faith hired Tim, a fellow teacher from the high school, to serve as the co-director for the science camp. Tim teaches high school biology in the classroom.
next to Faith, and he is also a member of the coaching staff for the high school football team. Faith and Tim have been working together for the last three years on the summer science camps.

During the summer, the high school students served as leaders for small groups of campers for half days over two weeks. To establish the staffing for the summer science camp, Faith focused on Eastern High School students. She used a formal process for selecting these eight leaders from among the students who applied. “We use an application process,” she told me. “We advertise through Channel 1 [high school announcements broadcast through television during homeroom], I have applications here (in her classroom), and I give them to all the science teachers to let them know it’s available.” When Faith said “we,” she was including Tim, the fellow teacher who served as her co-director for the last four years. For this year’s camp, Faith had 25 applications for the eight paid spots. Faith said that the number of applications had increased in recent years. The high school leaders get paid about $8 dollars an hour for the two weeks of camp. The fact that the camp offered paid employment helped increase the numbers applying. As Lacy, a high school leader, stated, “It helps that the position is paid, but I think I would have still applied. I like working with kids, so it appealed to me.”

As part of the process, Faith considered the following when it came to selecting students: “We want the students to be available for both weeks, we look at recommendations of their science teachers, we like to see prior experience working with kids, and we want students who say that they really like science. We pay attention to gender and diversity as well.”

When I asked Steve, one of the students, about his reason for applying to be a camp leader, he said, “I heard about it when I was in Ms. Faith’s chemistry class. She was talking about it. And I was just looking for something to do over the summer, and the fact of being able to have fun and also the pay was also kind of something that was ideal for something to do. It’s
good for applications for colleges and stuff like that, too.” Steve explored working as a camp leader at other summer camps, but he picked being a camp leader for the science camp: “I like science and math for some odd reason. It’s easier for me to get, so, I like the idea of science, and I like the experiments of science and how different chemicals react.” He shared an experiment from his class with Faith. “In Ms. Faith’s class, a lot of the times, we’re in the lab doing different experiments. Like one was with me and my two other partners, two of my friends in that class, and we had one experiment where we tested to see if there was nitrogen. We mixed a solid piece of metal, and we put it into citric acid or something like that, and we covered it with another test tube and afterwards we put a splint and we put it in and it like made a really big pop. We liked that. It was pretty cool.” He enjoyed the experiment so much that he looked forward to being able to lead younger students through similar experiments.

Faith recruited students through formal marketing, highlighting the paid positions and focusing on students’ desire to work with kids. Each year she provided fliers to all the Eastern science teachers and asked them to market the camp. In addition, she reached high school camp leaders through the relationships she built within the classroom and, as Steve described in his interview, the experiences she created for students during class.

In addition to high school student leaders, Faith recruited Tim, the current co-director for the camp. Tim told me that Faith approached him rather casually when she was hoping to have him co-direct the camp. He explained, “We were having a conversation, and then she said, ‘I’m doing a Science Camp this summer, and the theme is going to be engineering. Do you want to do this with me?’” Tim said Faith was excited about the camp each year, and she made sure that everyone involved enjoyed being part of it. Faith brought everyone together to help plan for the
camp; got them involved in picking the different activities; created camp t-shirts to create a sense of unity; and used rewards such as pizza, ice cream, and paychecks for the leaders.

Tim reiterated something another teacher who helped Faith in the past had told me: “Faith creates an equal partnership with the teachers who help. Ideas are always welcomed and included in the camp.” Faith shared leadership responsibilities with the co-director as well as the students. At the end of each camp, Faith collected survey feedback from the high school leaders. All eight of the high school leaders (100%) responded that they were given enough freedom, and their ideas were listened to. After each day of the summer camp, Faith and Tim gathered the high school leaders. Faith asked the leaders to share what they felt worked well, what could have gone differently, and what ideas they had about the activities planned for the next day. Faith and Tim incorporated the student leaders’ comments and suggestions to improve the camp. Tim and the high school leaders appreciated Faith’s shared leadership.

**Infusing school science curriculum in summer spaces.** Each year, Faith worked to develop a new theme and brought in new experiments and active learning stations that allowed elementary and middle school students to physically explore a different scientific concept. Her hope was that students returned year after year, so she strived to make the curriculum and learning stations new and fresh. “I seek out new ideas. I look at the Internet. I mark things in magazines and newspapers. I talk with other science teachers. I am constantly seeking out new ways to teach science, new experiments.” On one occasion, I was standing at her kitchen counter. In front of me was a pile of magazines and science manipulative catalogues, post-it notes and scraps of colored paper marked various pages. When asked her about the pile, Faith proceeded to open one catalogue and excitedly show me a couple of new experiments she was considering for next year’s camp.
Some of her past camp themes included Polymer Party, Under Pressure to Have Fun, I Was an Engineer, Going Green, and Who Stole the Cookies. For the first time this summer, Faith has adopted curriculum materials from an outside source. The curriculum for this year’s camp has been provided by UIUC. She was excited by the newness of the field of nanotechnology, she saw the curriculum materials and learning activities in action through her involvement with the EnLiST grant, and she realized the materials and activities were a good fit for students within the summer science camp. The materials involved a lot of reform-minded science activities, and they exposed students to an area of science not typically covered in the standard Illinois science curriculum and textbooks. When talking about the curriculum, Faith said, “It’s a lot of work to develop new camp curriculum each year, but I want the students who are returning to be introduced to something different. To see and explore a different area of science. I don’t want them to have to repeat a prior camp.” A student who continuously participates in the science camps, which many reported they did, could attend nine years of science camp and not repeat a topical theme.

During one of the reform-minded science activities in the nanotechnology-themed Boys and Girls’ Club science camp, a fifth-grader, Antone, reiterated the value he was gaining for science through the camp. Antone approached me; his safety goggles were in place, and his hands were covered by latex-free gloves. A white paper towel was carefully perched between his two hands; it held a small, golden, translucent block he had created using 3-D printing. The yellow polymer of the block had seeped into the paper towel, forming a ring around the tiny block. I had seen several blocks created by the different students, and his block looked nearly perfect. The corners were sharp, the tiny circles on top of the block were circles, and the block looked very much like a miniature version of a Lego. He asked, “Pretty amazing isn’t it? I
didn’t know I could do this. I sure hope I don’t drop it. It’s small, and I would have to look a long time to find it.” He paused and then said, “You know what? I come to science camp every summer. It’s my favorite part of being at the Boys and Girls Club.”

I inquired about what makes science his favorite part, and he responded, “I get to DO science.” This was not the first time over the two weeks at the camp I heard students use the phrase “do science.”

I asked, “What do you mean when you say you are doing science?”

“We make things like this.” He held up his block. “We make things and we learn. I like science.” Antone saw science as something that can be used to make things and accomplish tasks he never realized he was capable of doing. Science was not just the facts and figures in a textbook, but it was an active pursuit that could be used to create tangible outcomes. Science was used in connection with a verb, a doing word, not just the nouns found in the textbooks and meant for memorization. The doing of science was at the center of the summer science curriculum Faith created for the elementary students.

Faith and Tim, the co-director of the science camp intentionally created a science camp focused on the active learning of science. Tim said, “So many young kids say, ‘Eww–science, it’s boring, I hate it.’ We want to change those negative connotations associated with science. During the camp, we try to add in more hands-on science experiments that are fun. We avoid doing boring science.” Tim equated the textbooks and worksheets that were found in many schools to be what he called “boring science.” He viewed science as an active pursuit through experimentation, and it was this kind of science exploration that he labeled as “fun.”

At both locations, the YMCA and Boys’ and Girls Club, enrollment in Faith’s science camp was strictly voluntary. Campers were not obligated to attend; those campers who did not
attend the science camp continued with their regularly scheduled summer activities. During Faith’s summer camp, students used experiments where they were physically and mentally active, worked alongside high school mentors, and explored scientific concepts. Since the advent of NCLB, science instruction at the elementary levels has been declining (McMurrer, 2008). Two studies in two different states indicated that over 40% of elementary teachers are spending 60 minutes or less per week devoted to science (Dorph et al., 2011; Griffith & Scharmman, 2008). In one week of summer science, students spent 10 hours in scientific exploration, and this was 10 times the amount of science instruction many of these students encountered during one week of attending school. Given that many of the campers returned year after year, Faith created a summer science program that met an academic need, but she has also created a program that was attractive to students. Faith brought a reform-minded science curriculum to a space where there had been none and to students that were spending less and less time learning science in their schools.

**Generating funds to create the science camp.** To fund the summer science camp, Faith submitted a grant application to a local organization that was committed to providing resources for area businesses. This organization donated between $6,500 and $9,000 annually toward the summer science camps. When additional funds were needed, Faith sought out support from area philanthropists that were known for supporting educational opportunities and youth programs. Each year, Faith secured $9,000 for the camps.

Faith spent time after each summer camp delivering thank you notes and official camp t-shirts to the sponsors of the camp. “I want to acknowledge those that helped us make the camp a reality.” Every summer, she reached out to the area newspaper and invited them to cover the camp story. Within the stories, the sponsors were given credit for their contributions to the
Faith also recycled as many materials from camps as possible in order to manage the overall expenses of the camps. In the event that last-minute resources were needed for her classes or the camps, Faith ended up using her own money. Faith had to raise the revenue needed to bring her idea into reality.

**Experiential Learning Across Settings: Seeing, Tasting, Hearing, and Feeling Science**

**The power of the senses.** There were similarities between the experiences Faith created during the summer science camp and the experiences within her chemistry and physics classroom. These experiences were rooted in Faith’s background and the value she placed on teaching science through providing students with active learning opportunities. The following vignette illustrates two central themes present in Faith’s classroom teaching as well as in her leading of the summer science camp: (a) providing space and experiences for students to explore using science and (b) appealing to students to use their senses when they encounter the world around them. These approaches were rooted in her own personal values toward science learning.

**Vignette 4.2: Open exploration and the sights, sounds, and smells of science.**

*Chemistry class, October 20, 2010, 8:00 a.m.* As the chemistry students entered Faith’s classroom, they each picked up two handouts from the lab table near the door. They looked at the board. A few took their seats at their desks and got out their books and homework from their backpacks. Faith had set up experiments at different locations within the room. Near the back of the room was an aquarium full of water. The bell signaling the start of the school day would not ring for a few more minutes, and two male students approached the aquarium. In the aquarium were three sealed, full cans of soda. One floated, and the other two were at the bottom
of the aquarium. One student picked up the floating can, turned to the other student, and said, “Hey, why do you think this one is floating?” Water dripped from the can he was holding in the air. The other student looked closer at the can. “I think it’s because it’s diet soda. Diet soda has more carbonation.” The student holding the can rolled up his sleeve, reached into the water, and picked up one of the sodas at the bottom of the aquarium. He looked them both over, moved both cans up and down in his hands, and then placed them in the middle of the aquarium. The diet soda floated to the top, and the regular soda sunk to the bottom. He poked the diet soda back to the bottom and released it, and it floated back to the top. “Hmm . . .”

The bell rang. He dried his hands on his jeans, and both the students took their seats. The first student had posed a question based on his observation. The other student had offered a possible explanation for the reason the diet soda floats. But was this explanation accurate? Will the original boy do further investigation? Based on his slight shoulder shrug and his eyes that peered back at the cans, I’m not sure he was convinced by the explanation provided.

At the front of the classroom, an old milk jug sat, bloated and misshapen. The jug seemed to be nearly bursting at its seams. As the students were getting settled, one curious student pointed to the jug and asked Faith, “What’s in that bottle?” Faith moved to front of the room and held up the jug. “I put a little orange juice in here and let it sit around for a few days.”

Faith slowly turned the cap of the jug, and air hissed out of the bottle. A pungent odor permeated the room. Students waved their hands in front of their noses, and a few cried out,

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6 Although both cans are the same size and volume, their mass is different. Regular soda typically has about 41 grams of sugar. Diet soda uses aspartame, which is significantly sweeter than sugar per gram. Unlike with sugar, only a small amount of aspartame is needed, so fewer grams sweeten diet soda. Even though both cans have a little air at the top, the diet soda is the one that floats because it is not as dense. (Source: http://www.stevespanglerscience.com/experiment/sinking-soda)
“Ewwww!” Faith smiled at the students’ reactions. “As the orange juice ages, it ferments, and it releases gas. When I open the bottle, the gas is able to escape.” As Faith allowed the gas to be released, the bottle crackled and slowly returned to its initial shape. She continued, “The gas smells, doesn’t it. You can’t see it, but you know it is there.” She moved her head back away from the bottle and waved her hand in front of her face.

Reformed-minded science learning: Personal values frame the teaching of science.

In the previous vignette, Faith appealed to the students’ senses of seeing, touching, and smelling. Within and beyond her classroom, she provided students opportunities to experience science. This commitment to science as experience was present in her background as well as visible through classroom artifacts.

Faith’s passion for experiential learning. As described in the vignette, students explored the concept of density with their hands and smelled the slow release of a gas that was the result of fermentation. Faith’s commitment to giving students experiences that appealed to their senses was connected to experiences she felt had formed her own love for science. Faith majored in biology and minored in physical sciences. “I was originally interested in forestry. I loved being outside, and I wanted an environmental biology degree.” She told stories from her childhood: “We [her family] traveled all over the United States. We tented, and we had a pop-out camper. On one trip it was so hot in the camper, it was better to sleep outside. I remember sleeping out on a picnic table and just looking up at the stars. On another trip, I saw a moose walk right by me. It was so close to me. Then, there was the time when we had to run into the tent because the mosquitoes were so bad. They were everywhere.” As she told these stories, there was enthusiasm in her voice, and I pictured all that she described.
She recalled having “three really good science teachers. I was always a very curious kid. I wanted to know how things worked.” With these teachers, “there were a lot of hands-on activities. I remember playing with crawfish in the mud and getting my hands dirty. I loved that.” She also shared a science experience from junior high that was a favorite, “I remember in sixth grade we got to take apart a chicken; we had to boil it and then we got to put the bones back together and make the chicken, glue it all back together.” She continued,

*I’m one that looks at something and says, “Okay why is your notebook put together that way? Let’s open it up and figure it out or dig into it.” I’m not good at just looking at something on the outside; I want to pick it apart; that’s the discovery part.*

It was this drive for discovery and through these physical experiences with nature and the world that Faith wanted to bring to her teaching. She wanted her students to be able to take things apart, explore how things worked, and discover.

Prior to starting college, Faith had considered a career in education. Her mother, a former educator, told her not to go into education because teaching jobs were scarce. When Faith started her degree, she found out there was a need for science teachers, and so going into education in science provided a viable path. Prior to starting college, she served as a day camp counselor for Girl Scouts. Given her love for nature and her experience working outdoors with the Girl Scouts, Faith said, “I thought being a science teacher might be a good fit.”

During her first year of college, she served as the outdoor education director for a 4-H camp in a small community. “I led hikes, coordinated canoe trips, and worked closely with kids. It was this experience that helped reinforce I was headed in the right direction in science education.”
Over the course of her teaching career, she continued her education and earned a master’s degree in physical sciences, “When I got my first teaching job, they said, ‘Oh, you can teach chemistry AND physics.’ I realized I wasn’t as strong as I needed to be in chemistry, so I went out and found some courses that helped me build up those areas.” Faith valued the importance of continuing her education in order to provide better learning experiences for her students. Through her continuing education, she gained new ideas for enhancing the science curriculum as well as ideas that she incorporated into the science camps.

*Classroom artifacts provide evidence of reform-minded science learning.* Faith’s commitment to reform-minded science learning was evidenced in classroom observations, but the physical evidence was also present within her classroom. On the first day I met Faith, I entered her classroom after the school day was over. The classroom was big, and it included three long lab tables at the back of the room with space for 26 student desks in rows at the front of the room. Along the wall were built-in wooden shelves holding beakers and lab equipment; glass doors allowed me to see that all of its contents were in neat order. The student desks faced a combination of chalkboards and whiteboards at the front of the room. The boards were on tracks, and Faith was able to slide them conveniently from one side to another.

We sat on stools at one of the lab tables in the back of the room for our first interview. On the lab table beside us were several white bridges made of drinking straws. I talked with Faith about these projects. Faith described how the students had worked in small, collaborative groups to build the bridges out of straws. She had solicited straw donations from a local fast food restaurant for this task. Faith said the original activity called for balsa wood and glue. “I knew the balsa wood and glue was not going to work for the bridges in the three days, and at the time, I didn’t know it was going to be humid. Thank God, I went the straw and pin route.”
To identify this change to the original design, she said, “I went on the Internet and found the straw and pin bridge design. I quite often go to the computer and seek out new ideas or I go and ask other teachers.” As she was talking to me about the project, I picked up the different bridges. They were sturdy. One bridge used a lot of straws, and it was heavier than the others. Another had fewer straws, but it was also quite sturdy.

![Figure 4.1. Straw bridges built in Faith’s science class.](image)

In addition to the bridges, there were calculations on the dry erase whiteboard at the front of the room. Faith said, “The students had to do a series of measurements to determine which of the bridges was the most efficient.” The calculations included the cost of the materials, the bridge’s mass, the cost per gram, the mass held, and the strength to weight ratio.
As I left Faith’s classroom, I noticed a display case in the hallway just outside her door. The title, “Science Camp Collage,” was at the top of the case. The case featured the various projects the students had done during the 2009 summer camp. The collage included pictures showing students making biodomes, identifying recycled plastic, participating in a trash scavenger hunt, making slime, having a recycled art contest, and planting trees. Other pictures included high school students working with grade school students at an area park.

Faith’s classroom and this display case were filled with the physical presence of students physically engaging with science concepts. Each project was a manifestation of the science being learned, and each project was created for a specific purpose. When looking for teachers who emphasize learning through experience, one might be drawn to the art teacher who had a room full of student artwork, or the band teacher who led the marching band through moving performances, or the football coach whose teams had produced a full trophy case. In this instance, Faith was making science an active, physical endeavor to be used in the world beyond
school. The experiences that students had within the classroom, the displayed artifacts of their science learning, and Faith’s background all connected to her desire to students to “get their hands dirty” when it came to learning science. Faith emphasized when leading scientific activities for students to look closely, listen carefully, smell deeply (even teaching students the way “scientists smell safely” by wafting a hand over the top of a vial slowly), touch meaningfully, and when appropriate, to taste.

Experiential Learning in Class: Giving Space for Open Exploration and Student Leadership

Overview of Faith’s classroom teaching style. As a teacher committed to active learning strategies and physical experiences interacting with science, Faith also employed other approaches within her classroom, during the road shows, and at the science camps. Faith was committed to (a) providing open-ended exploration as part of science learning and (b) activating students to take leadership roles within the classroom and beyond. These commitments are illustrated in the following vignette. To help situate the vignette, the vignette is followed by a description of Eastern High School, a high school labeled as failing based on NCLB standards. It is important to note that the setting, labeled by others as failing, was seen in a positive light by Faith. She was capable of seeing the possibilities where others more quickly recognized the problems.

Vignette 4.3: Students as leaders in learning through class projects, Principles of Engineering class, October 21, 2010, 8:35 a.m. It is the passing period between first and second hour at Eastern. Faith uses the few minutes between classes to prepare for her Principles of Engineering course. This course was part of a national curriculum developed by the nonprofit organization Project Lead the Way (PLTW). This organization partnered with
universities to provide professional development to school teachers and promote its curriculum. The University of Illinois was one of those university partners (see [http://www.pltw.org/about-us/who-we-are](http://www.pltw.org/about-us/who-we-are)). To be qualified to teach the Principles of Engineering course, Faith completed a graduate-level course at UIUC. She received graduate credit for attending, and the course prepared her to teach the PLTW curriculum.

The Project Lead the Way website described the Principle of Engineering Course as follows:

> Designed for 10th or 11th grade students, this survey course exposes students to major concepts they’ll encounter in a post-secondary engineering course of study. Topics include mechanisms, energy, statics, materials, and kinematics. They develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges, document their work and communicate solutions. ([Source: http://www.pltw.org/our-programs/high-school-engineering-program](http://www.pltw.org/our-programs/high-school-engineering-program))

Principles of Engineering was an elective class at Eastern High School. In the spring of 2010, of 11 students who were enrolled, 9 were boys and 2 were girls; there were 4 minority students. Although the course at the national level was designed for tenth- and eleventh-grade students, there was a mix of freshmen, sophomores, and juniors enrolled. Students were able to obtain college credit for this course if they passed a national exam through PLTW at the end of the course or if they took another PLTW course.

With only two minutes left before the 8:40 bell, the students arrived, set their backpacks down by their desk, took out a couple of handouts from their folders, got out tackle boxes, and placed them on top of the lab tables. Faith assigned a group member to serve as the recorder.
The recorder was to submit a daily report of the group’s activity. Recorders were to write down the contributions of each member, the group’s accomplishments, the goals for the next day, any questions the group had, any problems encountered, and if changes were needed.

The students arranged themselves in small groups and opened the tackle boxes. The boxes were filled with various machine parts: gears, levers, switches, and blocks. Faith reminded students as they settled into their groups, “You need to ensure that your group’s machine has one human start, and it needs to include three simple machines.”

I focused my attention on one group of three freshmen boys. Based on the way they were dressed and the social groupings of adolescents in high school, each of them most likely traveled in a different group outside the classroom. Frank had disheveled hair. He wore a worn-out college t-shirt underneath a plaid flannel shirt. As he was sitting at the lab table, he touched many of the different parts in front of him: a gear, a lever, a small metal ball. He took some connected parts apart, studied the different parts, and then put some together. Craig had a goth look to him as he was wearing varying shades of black, had longer black hair, and had on clothes featuring graphics from a Tim Burton film and the Insane Clown Posse band. He studied the machine they had built and made a drawing on his notebook paper. The third young man, Terrance, was wearing a collared shirt and pressed jeans that had the distinct vertical crease carefully made by a hot iron. While the other two provided many different ideas, Terrance remained quiet. When he offered up his ideas, the other two listened and incorporated the ideas into the project. After the group decided on their next steps, Terrance went to the tackle box of parts, selected the necessary parts, and added them to machine. When selecting the parts, he looked through several different options before he picked the one he thought would work.
Craig spoke up as the three were looking at their creation, “Something’s not right; I don’t like it.” The other boys didn’t object and waited for him to say something more. Their machine worked according to the expectations provided in the assignment sheet. I asked a question of the group based on Faith’s directions at the start of the class: “Does it involve just one human start?” Based on the design, the students could only start the metal ball one time, and it must travel through the mechanism without needing to be restarted by hand.

“Yes,” Craig said, with his gaze squarely on the machine.

“Does it have three simple machines?”

“Yes,” he responded staring steadily at the machine. Craig said the word yes slowly and his steady gaze communicated to me that he was in deep thought. He was patient with these questions.

“So you’ve met the requirements of the assignment,” I said, hoping to explore why they still didn’t feel finished.

“Yes,” he responded.

“Why don’t you stop?” I was curious but wanted to be careful so they did not feel pressured to stop.

“It’s not what I have in mind. It’s clunky—not smooth,” Craig responded.

Frank and Terrance agreed with him, and they offered up ideas that might increase the smoothness of the machine. Terrance asked, “What if we get a couple more of these, and we put them here?” He held up two flat, red plastic pieces and pointed to their ramp. Craig and Frank nodded.

Frank dismantled several pieces and waited for the arrival of new parts. To give this group some space and time, I observed another group for a few minutes. After time passed, I
returned to Frank, Craig, and Terrance. The design of their machine had changed significantly, and it no longer worked. They were still making adjustments.

I posed another question: “Are you happier with this design?”

They responded, “Yes.”

Pushing them further, I asked, “But, now it doesn’t work?”

“No, not yet,” responded Frank.

“We’re getting there,” Terrance said, providing reassurance.

Figure 4.3. Students in the Principles of Engineering class complete a simple machine activity.

The group did not feel pressured to turn in a product as soon as it met the requirements of the assignment. They thought it was not yet what they wanted it to be, and they felt comfortable to push their design further. They wanted to create a product that went beyond the requirement, worked smoother, and met the vision of the final product they had in mind. Faith, who was present in the room, moved between the groups, remained aware of what was happening and offered assistance when asked. One of the groups was struggling to get their marble to transition through the different simple machines. They asked Faith for help. Faith
watched as they showed her their machine. She didn’t respond with a solution, instead asking, “What parts have you tried? What is stopping it from moving forward? What else might be a better fit here?” After each question, she provided time for students to respond. One of the students went to the tackle box and picked out three different-size ramps and returned; the group placed the different ramps into their design and tried again.

During the class, Faith let the students move through these stages of building, succeeding, changing, tearing apart, and rebuilding until it was time to share their final products. She was available to assist, but she let the students take charge of moving through the task.

**Context of Eastern: A struggling school full of possibilities.** The vignette was situated within Eastern High School, the only public high school in the city of Eastern. During my first visit to Eastern, I noticed the school resembled many midsized schools throughout the state. It was a compilation of old and new structures. The school included a series of additions that had taken place over the last 85 years. The most recent addition had come in the early 1990s, prior to the closure of the large manufacturing plant, and was built so the school could hold 2,000 students. Over the course of the last 20 years, the town’s population as well as the student population had declined. In 2011 Eastern High School’s enrollment was around 1,600 students.

Along the hallways of the school were framed photos of alumni who were famous inventors, actors, authors, public figures, and even an astronaut. As I studied the photos of the people who had graduated from Eastern, I was impressed by the alumni biographies that recounted vast accomplishments. These were people who had received academy awards; they were elected officials, best-selling authors, or philanthropists, and they varied in race and gender.
I considered the possibility that a school’s success may go beyond its test scores and include the success of its graduates.

Figure 4.4. Hallway at Eastern High School lined with photos of famous alumni. Photo altered to protect identity of school.

If measuring a school’s success can be based on standardized test scores (which many argue it cannot), Eastern was considered to be a school that was failing. Based on standards set forth in the NCLB Act, in 2011 Eastern finished its sixth year on the academic watch list. The goal of the Act was that test scores for all schools would improve from year to year; however, in 2008, 2009, and 2010, Eastern High School’s test scores had continually declined. These decreases came at a time when the standards had been raised for all schools, and these declining test scores put Eastern farther behind. In addition to its test scores, Eastern was hit by the fact that both city and state governments were facing economic crisis. The high school continued to experience additional funding cuts while being asked to continually raise the bar for academic
achievement, to restructure to improve test scores, and to provide more for those children most in need.

As the test scores continued to decline, the number of low-income students enrolled at Eastern continued to rise. Since 2008 the percentage of students who were considered to be low income grew from 45% in 2008 to 60% in 2011. The state average in 2011 was 48%. While the state’s low-income student enrollment had also risen, Eastern’s low-income student enrollment had risen at twice the rate.

During my initial visit to Eastern, Faith gave me a tour of the building. Along the way, I asked Faith about the photos of alumni I had noticed in the hallways. She told me a prior principal had added the photos to the hallways to enhance school pride and inspire students. During our tour, Faith stopped at one photo and pointed to a black-and-white picture. The photo included her mother as a high school student at Eastern. Faith told me her mother had grown up here, but Faith had not been raised in this town. She went on to say that when her mother found out that Faith and her family were moving to Eastern, she was excited Faith would be teaching at her alma mater.

As we toured the building, we entered different areas dedicated to music, art, drama, math, technology, English, history, and science. The traditional departmental divisions at Eastern were undergoing restructuring. Faith shared more about this recent restructuring. In the fall of 2009, Eastern had introduced a new school structure as part of its mandated school improvement plan. Rather than one centralized high school with various departments, the school had been divided into four mini-schools, or “houses” as Eastern called them. Three of the houses included different themes or core areas of interest, and one house was designed specifically for freshmen. The houses were Freshmen House, Academy of Creative Experiences (ACE), Global
House, and New Technology High School. Teachers were asked to indicate their preferences, and the school administration then assigned teachers to a specific house (not all teachers were able to be assigned the house of their preference). Although the different departments (Science, English, Math, etc.) still collaborated, the new emphasis was for them to develop interdisciplinary curriculum within their assigned house. Faith was a member of the ACE House. She stated, “ACE wasn’t my first choice; I wanted to be in new technology, problem solving. But there were too many of us in that one, and I said, ‘Okay, I’ll move over to ACE.’ I’m glad I did. I’m in the creative house. Our focus, our curriculum is centered on the arts. The art can be anything from a painting to an invention.”

When Faith talked about the restructuring, she spoke in positive ways and provided examples of how the change was benefiting students. She explained that the teachers and students came together and decided the following year’s theme for the ACE house would be relationships, and the Taj Mahal would serve as the masterwork and focal point. Faith spoke of looking forward to next year, and she was busy planning different lessons and developing new ideas for teaching science in a way that connected to the theme of relationships. Faith highlighted the benefits of having students arranged in these smaller houses rather than in a general population: Students were getting more services from the assigned administrators, students were taking more classes with one another and forming closer peer groups, and students were beginning to see connections between the different subjects.

“In the houses, they’re in a team, so that means a chunk of students has the same math, science, social studies, and English teachers. It is very well monitored by that team of teachers; the parents are being very well informed, attendance has gone up, and the graduation rate this year may be the best I’ve seen since I’ve been here.” When Faith started at Eastern in 2005, the
graduation rate was 70%. In 2010, the year of my initial interview, the graduation rate had increased to 80%. The discrepancy between the graduation rates of black and white students meant that Eastern did not meet Annual Yearly Progress (AYP) in this category even though the overall numbers reflected an improvement. The graduation rate for black students had grown from 63.8% in 2005 to 75.2% in 2010, but this rate remained below the 81.4% graduation rate for Eastern’s white students, and it was this discrepancy that prevented Eastern from meeting the graduation expectations set by NCLB.

It was within this setting that Faith taught high school science. Given the grim school statistics and the economic woes of Eastern, Faith’s tour, the photos, and her outlook on the new school structure provided warmth and color and imagined possibilities within Eastern. Faith’s belief in the school and the students had been recognized by others. In addition to teaching, Faith also served as the co-division leader (department chair) of the Science Department. Despite being relatively new to Eastern (arriving in 2006), Faith had grown to be respected as a leader by her peers and given department chair responsibilities. The apparent economic challenges of Eastern, a stumbling block for some, did not deter Faith. She recognized the positive within Eastern High School, she saw potential in her students, and she remained committed to creating opportunities for open exploration even when there were funding constraints.

**Open exploration curriculum: Student-led creations part of learning.** Faith saw her classroom as a space for students to explore using the scientific concepts she was teaching. “As a teacher, you are assigned the role as leader. I don’t always want to be in that position; I want the students to learn how to step up and lead. I want to see them interacting with one another building collaborative relationships. When they take on the role as leaders, they have the
opportunity to see what they can do.” Faith recognized the importance of creating learning opportunities within the classroom where students had to be in charge.

As a new member of the ACE House at Eastern, Faith actively looked for ways to incorporate the arts into her science teaching while also balancing her desire for students to have the ability to be in charge of their learning. Faith decided to incorporate a visual arts-based project in her chemistry classes to help students physically represent how matter can exist in different forms and how these forms connect to everyday life. Starting in early 2011, she formed the idea of having students put together a meal using the different forms of matter. In January 2012, I inquired about this project that she had been planning. Faith had implemented this new approach, and she provided the planning sheet for the project, the final rubric, as well as the peer-grading rubric. In addition, Faith sent photos of the students’ work. She said, “I was impressed with what the students did. Most [projects] were really good. I did have a couple [projects] that were bad. I was a little worried about how well the students would learn from this project approach rather than from what I had done in the past, but I used the same assessment as last year, and on a whole, there was a whole letter grade improvement for the class. There were a lot of As and Bs rather than Bs and Cs.”
Figure 4.5. Small group’s project of Create-a-Meal. The meal must include a solid, liquid, and gas; a pure substance; a homogenous mixture; a heterogeneous mixture; a food that went through a physical change; a food that went through a chemical change; items from each of the food groups; and a dessert.

As with many of the learning activities within Faith’s classroom, the students had an assigned task, they had freedom to work together to complete the task, and there was open space for working toward the task. Faith explained that she wanted students to discover using science, and she explained what discovery science meant:

*It isn’t cookbook [step-by-step], it is giving them [students] time and space to explore a concept on their own. It’s a time to let them mix and try things out to see what happens. I want them to ask “what if” questions, and then see what happens. I also want to ensure that they are doing it themselves rather than having someone else do it for them; they are the ones doing the experiment; they aren’t just watching it happen.*

As a teacher, Faith remained present and engaged but she acted more as a facilitator. She
actively assigned roles for students so that the projects moved forward and students were accountable to their group. While the projects separated Faith’s teaching from other teachers observed, her use of what might be considered to be traditional teaching was also present. Faith incorporated lectures, guided note taking, and chapter questions into her teaching. In addition, Faith did not abandon the need to assess student learning through the assessment methods often employed in high school science classrooms: chapter and unit tests. She recognized that the assigned curriculum must be followed, but she augmented the curriculum with experiences in which the students were in charge of creating a project using the concepts being covered through the “traditional” curriculum.

Science Learning on the Road: Making Learning Science Active in the Elementary Schools

The creation of the Science Road Show. During the course of this case study, Faith created a new opportunity for bringing science beyond the classroom. As part of the EnLiST project, the first cohort of teachers were asked to submit a grant application for an entrepreneurial project that increased science learning opportunities for students. For Faith, this project became the Science Road Show. The overarching goal for the Science Road Show became “to engage fourth-grade students in inquiry-based science learning with the help of high school mentors and to then showcase their learning to family members.” Prior to seeking funding from EnLiST, Faith secured a $500 grant from the district’s education foundation to help pay for t-shirts designed by one of her students, supplies needed for the different inquiry stations, transportation costs, a pizza party for the high school students who planned the Science Road Show, and the celebration when the Science Road Show was finished.

Initially, Faith hoped to partner with two Eastern junior high schools. After speaking with the two principals and making some initial plans, Faith faced a road block in the spring of
2010. “The [Science] Road Show is currently on hold. It was put in front of the board [Eastern Board of Education], and they wanted more information and wanted to make sure all the principals get together.” Faith explained that coordinating the schedules of the administrators as well as her own during the school year became “too crazy.” Including both junior high schools became too difficult to coordinate given Faith’s full-time teaching load, the timeline for getting the Science Road Show started, and the availability of all parties to schedule a meeting. Faith decided to try another route. To establish a partnership with a school, Faith reached out to an elementary school principal in the fall of 2010. The principal was a former Eastern High School teacher who Faith had worked with in the past. Through the principal, she was put in touch with Mr. Lamb, a fourth-grade teacher at the elementary school, and he helped to schedule a date for the Science Road Show. Mr. Lamb coordinated with other fourth-grade teachers so that all fourth-grade students were able to attend the show. Faith, along with eight high school students who volunteered to be mentors, designed different experiments to help students actively engage with scientific concepts. Between the 2010–2011 and the 2011–2012 school years, Faith and her students implemented the Science Road Show and visited two different elementary schools to provide activity-based learning opportunities in physics and chemistry to fourth-grade students.

The following vignette was pulled from the first Science Road Show that Faith and her students facilitated at an Eastern Elementary School. The vignette provides examples of how the high school leaders mentored the younger students, the types of science activities that were involved, and how Faith transitioned the responsibility of teaching science to the high school leaders.

**Vignette 4.4: High school students lead science learning for elementary students,**

Eastern Elementary School, Science Road Show, December 3, 2010, 1:00 p.m. *Faith and
eight high school students were setting up the first of two Science Road Show sessions at an Eastern elementary school. The two sessions were designed to accommodate the four classes of fourth graders. I joined two classes of fourth graders gathered in the old gymnasium. The wooden bleachers were pulled out, and we took our seats much like we were getting ready for a basketball game. Several tables were set up on the gym floor, and there was a stage directly across from us.

All the fourth-grade classes attending the Road Show were inclusive and diverse: There were students from a variety of ethnic backgrounds and students with special needs. Faith started the event by introducing each of her high school students and letting the students know the high schools were in charge of leading the different activities. She had each high school student share something about themselves with the grade schoolers.

Then, she and one of her high school students performed a short skit. Faith was facing the grade school students sitting on the bleachers. Her eyes reflected a mischievous energy as she said there was a “visitor,” which added a dramatic element to her introduction. She moved quickly across the gym floor, went to the outside door, gripped a handle, and slowly wheeled in a red wagon. The creaking sound of the wheels as they moved across the wooden gym floor echoed. In the wagon was Sarah, a female high school student, who was wearing a grey wig and cartoonishly large sunglasses. The students on both sides of me stood up to see. One of them laughed at the sight of Sarah. Faith asked the grade school students, “Do you know who this famous scientist is?” Many students called out, “Einstein.”

Faith provided a hint. “This scientist lived long before Einstein.” She pulled out a soft toy apple and dropped the apple onto the scientist’s head. Sarah made a face as if she was in pain; then she slowly rubbed her head, and the grey wig moved up and down. The students
chuckled at the face Sarah made. Sarah stroked her chin and looked off into the distance. Faith began a dialogue with Sarah about why the apple fell.

Faith told the grade school students that this scientist was Sir Isaac Newton, and “he was curious about what caused the apple to fall, and so he began studying forces.” Faith bent her knees deeply and pushed the wagon slowly and with great intention. She strained her voice as she pushed Sir Isaac in the wagon, “What type of force is this?” The children shouted, “Push.” She leaned far back, planted her feet, and pulled the wagon closer. The wagon moved slowly. She again strained her voice as she said, “What type of force is this?” The children shouted, “Pull!” Several more students stood up to get a closer look as to what was happening; two teachers moved through the bleachers and quietly reminded them to have a seat. Two complied, but each sat with one leg folded underneath so that they were still able to sit taller and get a better look at what was happening on the gym floor. Faith said, “Today we are going to do some experiments that show the different forces.”

Faith increased the volume of her voice, added a layer of excitement, and put her had to her ear after she shouted, “What are we here to learn about?” The children shouted, “Science!” She continued, “What concept?” They shouted, “Forces!” She told them that they would have an opportunity to “play using the different forces,” and the “high school students are here to help you learn more about forces.”

In the gym, there were six tables set up. Some tables had two high school students and other tables had one high school student. Each table had two or three activities. Faith gave each elementary student a number one to six, and they then moved to their assigned tables.

The high school students had worked with Faith after school, considered different force activities, and told Faith which of the activities they felt the elementary students would enjoy the
most. Faith selected the activities based on what the high school students had told her, and she allowed the high school mentors to work at the station she or he liked best.

One high school student, Tamara, had a serious look to her. She smiled sparingly, but when she did, her face lit up. She showed me her handwritten note cards for the experiment, and the cards were filled out on both the front and back. One note card featured a diagram of the experiment. As she showed me her note cards, I noticed her long were carefully painted. There was a white swirl and diamond-like jewel on each of the nails.

Tamara told me that she had spent three afternoons after school going through different activities, picked the ones she felt were the best, and prepared note cards with directions and explanations of the forces at work. All of the high school mentors wore grey Science Road Show t-shirts with a picture of a semi truck and trailer with the wording “Science Road Show.” The lettering was maroon, Eastern’s school color. This young woman went on to tell me that she wanted to be a doctor, and that science was important for her. She said she enjoyed being around little kids. “Doing this [event] was a good opportunity to work with kids and do science.” Faith was also wearing a Science Road Show t-shirt—the only difference was that the back of her shirt had the word “Driver” on it. She was the one who drove the high school students to teach the grade school students about forces.

The elementary students were split into small groups of three or four, and the groups rotated from table to table. As I was watching a group of students figure out how to knock a pie tin holding a golf ball to have the golf ball land in the supporting cup, a balloon flew over my head. Off to the side, a student attempted to yank a tablecloth and leave the dishes standing. The first attempt wasn’t successful, and the plastic dishes crashed onto the gym floor. All the
students including the high school mentors were wearing safety goggles. I moved over to the
table cloth experiment.

Figure 4.6. The high school leader helps the elementary school student learn about inertia
through a table cloth demonstration.

At this table, the two high school students explained the concept of inertia. Rosa had
long black hair pulled into a loose ponytail and big hoop earrings. The goggles’ strap made a
line around her head but disappeared beneath the ponytail. She told the elementary students at
her table, “The items on the table want to stay at rest, even when the cloth is pulled out from
underneath. This is inertia.” The other high school student, Cindy, had long light brown hair,
and I learned during her introduction that she was a cheerleader. Cindy said, “The cloth does
cause the items to move a little. That’s because of the friction. If you do it right, there isn’t
enough friction to cause them to fall.” The elementary students listened intently. There was
plenty of noise surrounding us, but the students’ focus was on the table.
As the elementary students took turns, the high school students asked the students to observe what worked best when the table cloth was pulled: pulling it fast, pulling it slowly, lifting the cloth slightly, keeping the cloth straight. A young girl with pigtails and purple beads pulled the tablecloth hard and lifted her arms up by her chin as she yanked back. The items tumbled to the floor. Rosa asked, “What happened when you pulled up?”

“The stuff fell,” the young girl said with slight disappointment.

“What can you do differently?”

“I’m going to try and pull it straight back.” The student was eager to try again.

Rosa affirmed this response: “You want to reduce the friction. You are pulling the items up off the table so they come crashing down. Try again.”

This time the girl pulled the cloth fast and straight back, and only one of the objects tumbled off. The girl smiled, and so did Rosa. Rosa patted her lightly on the back. The student returned to her chair, and Rosa had another student come up to try.

Off to the side of this table, two students were racing with brooms. One tried to push a basketball along a squiggly line of tape on the gym floor, and the other tried to push a bowling ball along a straight line. The student pushing the basketball was able to move fast, but he struggled to keep the ball on the line. The student with the bowling ball was moving slower, but she was doing a better job following the taped line. Prior to starting the race, the high school students asked which one would win. Because the students knew that the basketball was lighter, they believed that the basketball would win. When the two students finished the race, the high school mentors asked them why the one with the bowling ball finished faster. Tim, a fourth grader with a t-shirt featuring Sonic the Hedgehog, responded, “The bowling ball kept moving in a straight line when I pushed. Teresa had to keep stopping the basketball and changing
directions.” The high school mentor added, “A body in motion tends to stay in motion. The bowling ball gets to stay in motion, and the basketball needs to have a force change its direction.”

Figure 4.7 At the Science Road Show, students learn about bodies in motion including those traveling in a straight line and those that change directions using a bowling ball and a basketball.

Faith circled the gym, took pictures, and offered help when the high school students needed it. Her students took on the leadership role, and Faith provided the support when necessary. I had moved to the table where students were rolling matchbox cars into one another. There were matchbox cars of varying sizes, and the students were observing the impact of the crashes based on the size of the vehicles. Tara was the high school mentor at this table. She had hearing aids in both ears and wore glasses. When she talked with the fourth graders, she was animated. When two boys picked up the largest matchbox cars, she exclaimed, “Oh, boy, this doesn’t look good! What kind of crash are we going to have?” Three of the kids shouted, “BIG!” She laughed and lowered her voice. “How come?” A little boy with thick glasses responded, “They have the two biggest cars, so it’s gonna be a big one.” She moved to the other
side of the table and said, “I’m standing back then!” The little girl walked over and stood close to her side as they got ready to watch the collision.

Faith came up to Tara and quietly asked, “How is it going? Is there anything you need?” Tara responded, “It’s going well.” She handed Faith a car from her pocket and said, “This one isn’t working anymore.” Faith took the car and placed it in the box near the stage.

At another table, one of the experiments wasn’t working as well as the leaders had hoped. Faith went to a box and brought back something else for them to use. In many ways, Faith faded into the background while the high school students led the younger students in the activities. She provided the high school students the resources to teach and lead, but she allowed them to lead. The Science Road Show highlighted the high school students’ ability to perform science, and she was the director. They were now center stage of the show.

Generating science opportunities: Teaching strategies used in camps, classroom, and road shows. A teaching strategy that carried through the camp, the classroom, and the road show was Faith activating her students to “do science.” It was the doing that drove the activities that Faith selected for her classroom as well as the activities that became part of the camps and road shows. To identify the active experiments for road shows and science camps, Faith explored different activities that relate to the core topic being taught. As she indicated, “I knew that we were going to do the first Road Show about forces, so I had varying activities that I had used in the past at the science camps; I had read about others on the Internet, and I had a few I had heard about from other teachers.” Faith also recruited the Science Road Show high school leaders and had them investigate varying activities after school. She encouraged them to identify activities by looking on the Internet, by remembering activities from their past classes, or by
coming up with their own. The act of looking for science-based, active learning strategies became part of the learning process for the high school leaders.

Within her classroom, and with the Science Road Shows and summer camps, Faith placed a high emphasis on providing experiences for students to do experience-based learning related to science. This desire to have students work with scientific concepts made the science active and avoided presenting science as a subject to be passively studied. Faith, the high school leaders, and the elementary students often referred to “doing” science when engaged in the learning opportunities Faith created, and this seemed unusual. I had always used the wording we “studied” science, or I “learned” science. These students talked about “doing” science.

Tamara, a high school leader for the Science Road Show, provided her perspective into the act of doing science. “I think it is fun to be doing stuff about science rather than looking at a book. We can learn it on our own rather than the teacher just telling you.” I asked her if doing science was easier than reading about science. She stopped, paused for a moment and then brought her eyes up so that they were directly looking into mine. “It’s not about being easy. It’s about being challenged and trying to figure things out on your own. That’s not easy. It’s more interesting.”

Faith said, “I want the kids to be exposed to science they enjoy learning, I want them to be exposed to science that they may not get to see until junior high, and I want to provide experiences for high school students to work and teach younger kids with science.” Faith’s desire to have the high school students lead science learning activities and the young students explore with active, physical activities was what drove her to create opportunities that could not exist within the given structure of school. Faith had to go beyond her classroom to build her vision of cross-age group, active science learning.
Support for School Science Beyond the Classroom: Collaborating with School, Community, University, and Individual Sponsors

Generating support. The science camp, the Road Show, and even the project work within Faith’s classroom required ideas, resources, and donations. Faith leveraged resources by seeking out ideas, by building connections with the community of Eastern, by establishing relationship with the University of Illinois, and by soliciting donations from individual members within the community. The following vignette illustrates Faith’s ability to connect community resources within the science camp. It is this ability to connect resources with science learning needs that provides Faith the needed support to create new science learning opportunities.

Vignette 4.5: Outside resources provide new opportunities for science learning.

Eastern Boys and Girls Club, It’s a Small, Small World Summer Camp, Thursday, July 7, 9:40 a.m. The 2011 Summer Science Camp theme was “It’s a Small, Small World,” and Faith picked this theme because of the nanotechnology professional development workshop she completed through EnLiST. She said, “Nanotechnology was so new to me. I didn’t even know about it until I was in EnLiST. I thought it would be great if we could get the kids using new technology and learning about something that is relatively new to science.” She continued, “I want to expose them to a new topic that they might not know about. I want to get away from the textbook method of learning science, so they change their mindset of what science is. They need to know that science is discovery.” Faith pointed out that nanotechnology was so new that it wasn’t even in many of the textbooks, and this made it even more important for helping kids learn about it.

Faith partnered with UIUC to incorporate nanotechnology as a theme. Faith and the high school mentors used “kits” provided by the university to teach nanotechnology to first
through eighth graders. She said, “The kits were already put together, the university donates some of the materials to be used, and the activities expose the kids to new technology.”

She also shared that there was a benefit to having the high school students lead the activities with nanotechnology as it was new to them as well. Steve, a sophomore who served as a camp leader, stated, “I am curious about the possibilities with it [nanotechnology]. We are going to show the different things that have been made using it, and that’s pretty cool.”

With both the science camps—the YMCA and the Boys and Girls Club—Faith wanted to ensure that the students had the opportunity to use nanotechnology to make a 3D print of a block. Faith, with the help of a professor from the university, John, brought this activity to the camps. John informed me at the YMCA camp, “Outside of the university, I have never done 3D printing with an audience this young. With the assistance of the high schoolers, Faith assured me she felt that this would work.”

For this activity, John brought a car full of equipment. At both camps, the high school leaders went right to work setting up the equipment on each table. Each table required a laptop, a cord, an LCD projector, a beaker, and mirrors carefully attached to rods. Evan set up his table quickly and carefully. When he finished, he worked with John to help others get everything ready.
Figure 4.8. High school leaders set up the 3D printing activity. The science of this lab was described through the Nano-CEMMS web site: “This lab uses a process based on a research project headed by Professor Nicholas Fang and developed at the Nano-CEMMS center at the University of Illinois. Dr. Fang's research group is using a UV sensitive monomer to do a form of three-dimensional printing called microstereo lithography. Using a video projector with a UV output, they are able to create incredibly thin polymer layers (on the order of 400 nm) and build objects layer by layer. This activity uses the same principle but at a much larger scale. This activity demonstrates the basic challenges of nanoscale engineering and manufacturing.”

(Source: https://nano-cemms.illinois.edu/materials/3d_printing_desc)
Figure 4.9. Students create a 3D polymer block. A student counts 10 seconds using his hands as the other student gets ready to turn the knob to lower the platform holding the beaker.

At the end of the day while packing up the 3D printing equipment, I talked with John, the university professor who conducted the 3D printing with the camp, and inquired how he thought the activity went. He responded, “It worked VERY well. It’s nice to have so many high school students helping. That made the difference.”

Typically, this lab was done with high school students being the recipients and occasionally with those at the middle school level. Rarely has it been done with elementary school students. Without the leadership of the high school leaders, the connection Faith made with the university, and the science camp offered at the community centers, this opportunity for elementary school students to create a 3D print of a polymer would not have happened. These students now knew that 3D printing was a possibility through science, and they were capable of
actively using this technology.

**Seeking resources.** The resources to build bridges in class, the money needed to create annual camps, and the necessary expertise and equipment to bring new forms of science learning to students were not readily available to Faith. She actively sought out the resources needed to create new learning opportunities. Faith reached out to members of the community to identify sponsors for science learning within and beyond her classroom. She used a variety of avenues for getting the resources she needs. When it came to building the straw bridges, she reached out to the local McDonald’s and was able to get the straws donated. When she and her students identify learning activities for the camps, she scours through past equipment and supplies to see what is ready to be re-used and recycled. When it comes to funding the camps, she submits grant applications and canvases area businesses for donations. The Science Road Show was paid for through a grant through EnLiST as well as a grant provided by the school district.

The science camp operated beyond the confines of Faith’s classroom and school, and the funding and resources to make it a reality had to come from beyond Faith’s role as a teacher. Faith did not allow a lack of available resources to inhibit the science learning she hoped to create. Faith spent time after each summer camp delivering thank you notes to the area sponsors as well as the official camp t-shirt: “I want to acknowledge those that helped us make the camp a reality.” Every summer, she reached out to the area newspaper and invited them to cover the camp story. Within the stories, the sponsors were given credit for their contributions to the camps. As Faith noted, “The stories allow our sponsors and those that support the YMCA and Boys and Girls Club a chance to see their donations at work.” When I sat down with a sixth-grade girl at the YMCA, she referred to a story she read in last year’s newspaper. “I saw my friend in the newspaper, and he was at the science camp. It looked like they had a lot of fun
doing experiments, so that’s why I signed up this year.” The newspaper coverage provided ways to thank sponsors, but it also generated interests for new campers to attend the summer program.

Figure 4.10. A summary of resources that Faith used to create the 2011 Summer Science Camp.

Faith is a seeker. She actively searched for resources, funding, and ideas to create science learning opportunities. For the 2011 Science Camp, Faith collaborated with the community to identify resources, the university to build new ideas and programs, and the area newspaper to promote the program as well as recognize community members who were supporting science learning beyond the classroom.

Structure of Schooling: Constraining Nature of Bureaucracy, Structures, and Curriculum

The challenges of schooling. In the following vignette, I introduce one of the challenges that Faith encountered when creating the Science Road Show. While the district and even administrators may be open to the educational opportunities presented by teachers, the actual navigation of the bureaucratic system requires time and energy. Faith emphasized the importance of having older students mentoring younger students, and this multi-age learning was
not inherent within the given structures of schooling. In order to create these educational opportunities that spanned the structure of schools, Faith had to identify substitutes to cover classes; coordinate transportation; obtain appropriate permission from parents, students, and teachers (for those courses students would miss); and gain multiple levels of approval, from building administration to district administration. The curriculum Faith used within her beyond classroom learning opportunities did not strategically align with the district-wide curriculum, so it was seen as supplemental learning versus accepted learning.

The following vignette raises an issue that other teachers have faced when implementing new ideas beyond their classrooms: the bureaucracy and structures inherent within public school districts. Faith had successfully created new spaces for elementary students to engage with science and created mentoring opportunities for high school students through the Science Road Shows; however, the ability to expand these ideas or embed them within the structures of Eastern school district were a challenge.

**Vignette 4.6: Limitations of growing school science within contexts of schools,**

*Eastern Elementary School, Science Road Show 3, April 17, 2012, 2:30 p.m.*  
The high school students were demonstrating the different aspects of monomers and polymers using a variety of experiments with chemical reactions. The students wore goggles. The room was busy, and I was standing back with the director of Eastern District’s Foundation. The foundation solicits funding from community organizations and members and provides those funds to schools and teachers who want to try new and innovative approaches to education. Faith had completed an application and received support from the foundation. The director was visiting to see the Science Road Show that the foundation had helped to fund.
The director is a retired police officer who wanted to stay active in the community, and he values the importance of education. He told me he was impressed with the Science Road Show and how active all of the students were. He said, “My focus is raising money for the foundation. I want to see this Road Show expand to all of the district elementary schools. This is great; the students are so engaged. They are wearing the goggles, they have on their aprons, and they are doing science. They look like scientists.”

The potential to grow the Science Road Show was intriguing, so I inquired, “How will you go about doing that?”

He answered, “I don’t know. That’s really beyond me. I’m not an educator. I know the educators are always concerned with the costs and the substitutes.” He clarified that when he said educators, he was including both the teachers and the administrators.

He went on, “In fact, right now, it is hard to find subs. They are also worried about missing class time, and administrators are worried about cost.” I probed more to determine if there was an approach that he would use to expand the Science Road Shows, but the conversation returned to the limitations that must be overcome in order to move forward.

Faith joined us, and the director turned to her and said, “This Road Show needs to be at all the grade schools. You’ve done this here and the elementary school last year, but we want all the grade schools to be part of this.”

Faith hesitated and placed her hands gently on her hips. “That would be great, but how would we do that?” She asks the question as an open inquiry rather than a challenge.

He looked toward the students and seemed not to hear the question, “This is so great . . . we want all the schools to be part of this.” He shook Faith’s hand and explained that he needed to get going.
I asked her more about the possibility of expanding. She said, “Yea, that is exciting, but I just don’t know how.”

“Who do you think would help?”

She responded, “I have no idea. I hope someone; I couldn’t do this. The time. I would need subs.”

I reflected back to a discussion I had with Faith at the very first Science Road Show. The high school students were busy loading all of their supplies before getting on the bus. Faith and I stood in the middle of the gym watching the high school students pack up their stations. I asked Faith how she was feeling and she smiled, “I’m exhausted.” I did not hear any despair in her statement. Rather it was said in the same manner as someone who had just finished a marathon and felt a sense of accomplishment.

I asked her to compare this experience to the science camp she had been doing for over 10 years. She responded, “It’s a lot more challenging. Partly because it’s new, but also because I still have my classes going on. It also required a lot of coordination, which meant that it drug out.”

In order to make this Science Road Show a reality, Faith needed to get the proper approval from administrators at both the elementary and high school, coordinate a day and time with the fourth-grade teachers, establish bus transportation, acquire permission slips from parents, communicate with the teachers of the participating high school students notifying them of the students’ absence from class, acquire the needed materials, transport the materials and the students to the elementary school, and find replacement teachers for the classes she would miss. Rather than spend extra money on the high school hiring a substitute, Faith found high school teachers willing to devote their planning periods to cover her classes.
She explained, “It was nice when it was finely here.” She went on to tell me of her chaotic morning. She had accidently grabbed her husband’s keys, and he needed them to get to a meeting in Champaign. She realized the mistake when she was teaching and knew she needed to rectify the key situation before the Science Road Show began. Balancing full-time teaching while also creating new learning opportunities beyond the classroom she said left her “exhausted” and “frazzled.” However, even when she was explaining her sense of exhaustion, she had a glow when she talked about the high school students and their interactions with the elementary students.

School structures not conducive for multi-age learning. The Eastern School District used widely accepted grade level divisions for their schools. Elementary schools were for students in grades K–5, the middle schools were for grades 6–8, and the high school was for grades 9–12. While the district office oversaw the curriculum for students K–12, the ability for students and teachers in the high school to interact and collaborate with students and teachers in the K–5 and 6–8 schools was limited. The physical separation of buildings provided a large obstacle, as most curriculum discussions, plans, and activities were designed at the building level. Those teachers who had ideas for multi-age learning had to work outside the established structures in place. Separate building located throughout the city also meant that transporting students from one place to another required planning and also missed class time. While the power of the multi-age learning opportunity Faith created was admired by teachers and administrators, Faith devoted a significant amount of time and administrative effort to work around and within the established school structures.

Layers of administrative work and approvals. Within Faith’s classroom, she was able to bring in experiential learning experiences that coincided with the curriculum being covered.
She was able to do this because her building principal was supportive of teaching trying new approaches within the classroom. “I invite him the principal in, I tell him, ‘Come look at what’s going on.’ It is an absolutely wonderful environment and reinforcement from my administrator.” Faith shared the administrative support that she experienced teaching within the classroom. The act of inviting the administrator into the classroom demonstrated Faith’s comfort and enthusiasm for the active learning strategies she used in her instruction. Within Faith’s case and her classroom, there were no administrative layers for approving the approaches she brought to her teaching. She was supported. When she attempted to take science learning out to other schools, this was when she experienced difficulty navigating the layers of administrative approval.

In the May prior to the first Science Road Show, Faith described the struggle this way: “I put the idea to the board [Eastern School Board]”. Faith developed a Science Road Show proposal, submitted it to the board for consideration at their bimonthly meeting, and received a response: “They said they wanted some more information and an okay from everybody involved.” Faith was charged with setting up meetings with the principals and others, and she was working on finishing out the school year with her classes. She said, “It just won’t happen until next year, but we’ve got to get it to happen. I’m not sure when I am going to get all the principals together. I’ve got to make sure to get all the principals together. When is that going to happen? I need someone to do THAT for me.” Faith’s comment reflected that she was passionate about following through with the idea, but that she faced a difficult task with little support. Her original design was to bring the Science Road Show to one of the grade levels at the junior high. When she realized she was going to be unable to coordinate given the schedules, she shifted to reaching out to an elementary principal she had worked with in the past. Faith was
able to pivot her idea and implement in a way that avoided what came to be an insurmountable task given that she wanted to start the Science Road Shows the following school year.

In order to bring the Science Road Show into being, Faith eliminated the levels of administrative approval required. While scaling back the project did allow it to take place, the Science Road Show reached a smaller number of students within the Eastern School District. Rather than the administrative layers supporting innovation and initiative, it was actually minimizing the impact. Once the Science Road Show was in place and the results were visible to the district, there was a desire to grow the program. At that point, Faith questioned what type of support she would receive from the district to make the program bigger. The district wanted expansion, but they offered no administrative or time supports to help Faith grow what they saw to be a positive science learning addition to the elementary schools. The expectation was that she would use her own time to create, identify additional resources, and grow the program. This expectation reflected the lack of awareness of what was involved in creating the program, and the time beyond Faith’s classroom responsibilities was a significant. The appreciation for the outcome was immense, but the support for growth was lacking.
Chapter 5: Using Science to Solve Real-World Problems

In David’s case, he created science learning opportunities for students after school and did so at the three different high schools in which he taught. Focused on giving students experiences to use science to solve local, national, and even international problems, David generated support for the learning opportunities not only within the community but also well beyond the community. Over the course of three years, David raised over $150,000 for the science learning projects he created. Throughout this chapter, vignettes are used to illustrate the issues within the case. This chapter examines (a) the actions he took to create two Biodiesel Initiatives and a School Beautification Project; (b) the school settings in which he taught; (c) David’s background and sense of caring and the connection to his teaching; (d) the experiential learning opportunities he created for students within and beyond the classroom; and (e) the structures and realities of schooling for a non-tenured teacher such as David.

Connecting Science Beyond the Classroom: Biodiesel, Electricity, and Beautification After-School Projects

A biodiesel club at Townsend. When I first met David, he had been teaching at Townsend High School for four years and had gained recognition for creating an after-school biodiesel program for Townsend students.

Finding a project that matters to students and impacts the community. Within the first year of teaching at Townsend, David noticed students were disinterested and disengaged in his physics classes. The students struggled to see how the concepts being taught applied to their world; however, David realized that Townsend’s lack of funds meant that getting new equipment was not going to be possible. David said, “We had very little money in the district, no money to get equipment, and I said well how am I going to get these kids interested. A lot of the kids
didn’t like being here. Sitting all day solving math problems, there’s nothing they can actually look at, hold, touch or feel. When we build something, at the end, the kids will take pride, be excited about coming to class.” While he felt strongly that students needed to be building using the science and physics they were learning, he wanted to find a topic that the kids cared about. He started brainstorming with the students to determine what topics they cared about the most. As kids talked about problems in their world, he hoped to identify science projects that would be interesting to them and address the problems that they identified. David found students’ biggest concern was at the gas pump, “The high gas price was something the students were really concerned about.” The students’ concerns connected to David’s past role as an engineer for an oil company, and David capitalized on this shared student concern. He posed an idea to his students, “I said, ‘Well, what if we made a biodiesel system? Do you think it would be fun to turn old cooking oil into biodiesel and then run it in a vehicle?’ The kids said, ‘Yeah.’ I said, ‘Well, we have to build it.”’ Through this class brainstorming session, the Biodiesel Initiative after-school program began. David and his students faced some uncertainties since David did not have prior experience creating biodiesel, and there were no district funds or resources to start this project. Even with these obstacles, David was undeterred by the lack of prior knowledge and the lack of resources.

David’s engineering background helped him realize that people can learn through the building process. There was no need to have all the answers prior to starting, and he was confident he and his students would figure it out together. “I had never built a biodiesel system before. I didn’t know how to go, so I just started walking down the path. As you’re going, you learn from the mistakes. The kids were right along with me. It’s kind of a good thing for them
to see that you don’t necessarily need to know everything before you go into something new. You just start it and as you go, you learn. That’s what a true science research project is.”

As the students started to build the biodiesel system after school, more and more students became interested and joined the club, “I had kids I never knew before come by after school and say, ‘Wow, that’s cool, we’d like to know about it, what are you doing, can we help?’ I said, ‘Sure.’ Biodiesel became popular with the kids.”

**Incorporating Advanced Placement physics at Townsend.** In addition to the biodiesel initiative, David started the first Advanced Placement (AP) physics class in the school’s history. David recognized that students in his classes and in the biodiesel club had an aptitude in physics, and he felt that his students would do well with the AP curriculum and felt that the class would prepare them for college. The presence of AP physics is uncommon in urban schools with high poverty student populations (Rado & Malone, 2011). Given that 76% of Townsend’s student population was considered to be low income, the lack of AP physics prior to David’s arrival matched similar schools with similar student populations. After two years of offering the course, over 35 students gained interest in taking David’s AP physics course, and Townsend switched to offering two AP physics courses, and those were nearing capacity.

**Securing funding, resources, and support to start the project.** To fund the project, David wrote and was awarded grants from BP/Amoco, Toyota Tapestry, and the Lexus ECO Challenge. The grants outlined how Townsend students would build a biodiesel system, gather used cooking oil from local restaurants, and recycle the oil so that it could be used in the school’s lawnmowers. In addition to the grant funds, David and his students collected donations from a variety of community organizations (home improvement stores, a steel bin manufacturer, an electrical company, a caulking company, restaurants, and more). Using the donations, he and his
students built a biodiesel system that converted used cooking oil into biodiesel fuel. David worked with the district, and the biodiesel fuel created by the club was used in the school lawnmowers. The club also explored using their biodiesel fuel to power a diesel school bus.

Their unofficial after-school club came to be known as the Townsend Biodiesel Initiative. During the course of the project, the Biodiesel Initiative collected over 250 gallons of used vegetable oil from the school, the community, and 12 different food establishments. Other schools gained interest in the Biodiesel Initiative and asked David and the club to come and speak at their schools. David and his students developed a biodiesel presentation including a PowerPoint that outlined the club and the work that they were doing. The PowerPoint included the club’s shared mission statement: “To lower the CO₂ emissions by diesel vehicles used by the district, to promote education of renewable energy sources, to involve the community in saving and recycling used cooking oil, to make the initiative a model for district and community biodiesel production, an to expose students to a project involving green technology.”

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7 The term “unofficial” is used here as the club was not officially recognized as a school-sponsored organization. Rather, it was a club that David created. He did not receive a stipend for the work he did with this group of students.
**Figure 5.1.** A summary of resources David used to create the Townsend Biodiesel project.

*Impacting lives and infusing a humanitarian focus.* As the project grew, the students’ work won a national contest focused on teens making a difference for the environment. The contest included entries from 750 schools across the United States. David contacted news outlets to let them know about the success of the Biodiesel Initiative, and the Initiative was covered in local newspapers and television news outlets. Through this media coverage, David’s project gained the attention of a Michigan State University (MSU) graduate student who was working...
with Engineers Without Borders. The graduate student contacted David after learning about the Biodiesel Initiative, and she inquired about partnering on a project. Engineers Without Borders had recently built a school in Pichon, Haiti, and the MSU graduate student hoped that the work that Townsend’s Biodiesel Initiative had done with biodiesel could be useful to the Pichon community and the school. David’s students could help to build another biodiesel refinery, construct solar panels, and send those to the school with the goal of bringing electricity to the school.

As David talked with the graduate student, he realized that this was an excellent opportunity for the Townsend students to draw a connection between environmental science, the work they were doing through the Biodiesel Initiative, and how their work could positively impact their global society. By partnering with Engineers Without Borders and Pichon, Haiti, the students were able to do something for others, and for David and his students, the project became a humanitarian effort with biodiesel fuel as the central tool. David said, “Kids innately want to help somebody who has less than they do. There was a make-me-feel-good-reward. It made the project bigger.” The ability to bring electricity where there was none meant that the science the students were doing had meaningful, impactful results. At the beginning of the project, David wanted students to build something that they could physically see and touch; now, the project went further. The students were able to see the biodiesel system they created, but they were also able to see the impact that a biodiesel system could have for others living without electricity.

8 Engineers Without Borders-USA (EWB-USA) is a national organization that began in 2002 and has approximately 12,000 members. Through this organization, members within the fields of public health, engineering, anthropology, and business work with communities and nongovernmental organizations to develop sustainable, practical solutions for areas of the world that are resource deprived and have significant infrastructure needs (Engineers Without Borders-USA, 2012). Please add this source to the references.
Extending and growing a network of support. Early on in the project, David recognized that the available resources at Townsend were limited, and he would need to reach out beyond the school to find the equipment, materials, and support they would need to build the Biodiesel Initiative. In addition to acquiring grants and donations from local businesses, David and the Townsend students traveled to different elementary and high schools to share the work they were doing and teach students about making and using biodiesel fuel. The Townsend students presented the project and gave demonstrations on how to make biodiesel. As a result of a presentation for an environmental club at a private, all girls’ Catholic school, Blessed School⁹, the school’s club and its advisor asked to develop a partnership with Townsend. They wanted to help with the humanitarian effort to bring electricity to the Haitian school. David welcomed the extra support and students.

With the addition of creating a biodiesel system and solar panels for the school in Pichon, Haiti, David realized they needed more expertise to accomplish this larger task and continued to look for new partnerships. David reached out to the dean at the University of Illinois at Chicago’s College of Engineering, who invited students from Townsend and the private high school to meet with four different campus organizations to discuss the project and establish a plan. The University of Illinois, similar to Michigan State University, also had a campus Engineers Without Borders chapter, and the organization of college students offered and provided a design for a solar paneled biodiesel processor. Using the design created by the University of Illinois Engineers Without Borders, David’s students went about building the equipment.

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⁹ Pseudonym used for the school.
Along with building relationships with universities, David sought out financial and material resources including solar panels, shipping materials, parts for the biodiesel system, electrical wiring, and tools. The necessary materials were costly: David estimated at least $50,000 in raw materials, and these materials went well beyond what a school would be able to acquire and support.

David mentioned his background played an important role to his ability to seek out the needed materials. “You know I didn’t go to college right away. I funded my own way. I had to figure out a way to pay for it, and I did. I’ve always been someone who is scavenging things. If I see a piece of wood in the trash, I pick it up and figure out what I could use it for. This scavenging comes naturally for me, and that has helped.” David worked with his students to scavenge the resources from a variety of places.

Navigating around the bureaucratic structure of schools. The large grant funds issued to David were to be used for the Biodiesel Initiative, and the grant outlined the expectation that David should have open access to the funds. Being awarded such large grants with funds directly awarded to a teacher was new to the district, and the administration was not comfortable with David having open access to the account as a teacher. They felt the need to oversee the funds in the same way they did for other student organizations, so the school implemented a number of procedures David needed to follow in order to access the money. With the growing number of administrative obstacles, or “red tape,” David became frustrated by the constraints and unnecessary paperwork particularly given there was a significant humanitarian element and timeline for project completion. He said, “They started telling me I needed to give them three weeks’ notice if I wanted to go anywhere or do anything. Instead of saying, ‘Mr. Dressler, what can we do for you?’ they started imposing rules and restrictions. They said I had to submit an
email with a spreadsheet if I wanted to buy a screw! That’s not helping me; that’s imposing restrictions.”

David realized that these delays were going to mean that they would not meet the deadline, so David turned more and more of the project over to the Blessed School that was now partnering with Townsend. The private school donated the space to house the biodiesel equipment when a request for room at David’s school had been denied. In the end, the private school completed the project. At the private school, an administrator remained actively involved in the project and offered her support for the work being done. David knew that the success of the project hinged upon administrative and school support. His students still helped when they had submitted the necessary paperwork to be involved and acquired parent permission.

As the project shifted more toward the Blessed School, David collaborated with the Blessed science department chair and wrote more grants. In partnership with the private school, David and the private school’s environmental club raised an additional $20,000. In addition, David, the Townsend students, Blessed School’s environmental club advisor, and Blessed School students solicited and acquired donations through area businesses such as Home Depot, Huen Electric, Carbon Green, Meyer Drums, and Turner Construction. Together, they secured the needed resources, built another biodiesel processor, built solar panels, and shipped all the equipment to Haiti. The Haitian school planted the Jatropha\textsuperscript{10} seeds and used those crops to create seed oil. The school then used the biodiesel convertor built by Townsend’s Biodiesel Club and the Blessed School, used the solar panels to power the processor, and in the end these high school students successfully used a design, build, test cycle to provide electricity to a Haitian school.

\textsuperscript{10} Jatropha is a plant that grows well in tropical climates such as Haiti. Because of deforestation, access to energy sources for biodiesel is limited. Jatropha crops provide an easy-to-grow source of biofuel.
The grants and David’s work provided not only funds but also notoriety for the school and the students. Students from his classes and beyond (through word-of-mouth) stayed after school to build this engine and gain experience working with tools and building something novel. David’s activities were recognized in the community and beyond, but David faced hardship at the end of the school year. The district implemented a reduction in teaching force due to budgetary reasons, and David received a pink slip. Although Townsend did not renew David’s teaching contract, the student newspaper, *The Bagpipe*, ran a story in its final paper for the 2009–2010 school year about David winning the Illinois Education Association’s (IEA) Teacher of the Year Award. David and an IEA official were featured in a photo, and David was holding his teacher of the year plaque. The caption said,

*Congratulations are in order for Physics instructor David who was honored as the State of Illinois “Teacher of the Year” by the Illinois Education Association. David, who was nominated by fellow Townsend staff member and I.E.A. official, will compete for the national honor this summer. He was feted for his outstanding work with the biodiesel program and solar power research. Way to go!*

The biodiesel project, the grant money, the addition of AP physics, the recognition from IEA, and the time commitment before and after school did not offer job security for David. The economic woes and the need to reduce current staffing dictated his fate as a teacher at Townsend.

**Bringing biodiesel to a magnet school.** In the summer of 2010, David accepted a math teaching position at a magnet high school in downtown Chicago. The principal there was impressed with the work David had done with the Townsend Biodiesel Initiative, and she hoped that he would create something similar at the magnet school. In the fall, David worked closely
with one of the magnet school students to create a new biodiesel club. David attributed the successful beginning of this new club to Li, one of the magnet school students. “Li had a science project that really connected with what I had done in the past. She really wants to do some amazing things.” Given Li’s interest in biodiesel and the proximity of the school to the University of Illinois at Chicago (UIC), David reached out to the university to see if they would be interested in helping. The university donated space for him and his students to meet after school, build a biodiesel system, and create biodiesel fuel. The club’s name was H.E.R.O.E.S. (Helping to Engender Renewable Organic Energy Sources). David and the newly formed club members put together grants and ended up winning over $30,000. David worked with members of the club to build a biodiesel refinery using the space donated by UIC.

The following vignette focuses on the actions the students took when participating in the H.E.R.O.E.S. project at the magnet school is the focus. The vignette highlights David providing spaces that (a) animate students to lead and (b) enhance partnerships through student leadership.

**Vignette 5.1: Student Leadership and Project Growth, University of Illinois at Chicago, December 3, 2010, 3:45 p.m.** It was after school on December 3, 2010, and I followed David and four of his students to a university classroom. The four students were members of a five-student biodiesel club. There was one male and three female students; two were white and two were Asian American. These numbers were significantly lower than David’s prior club at Townsend, and the demographics of this club were different than the Townsend’s club, which had consisted of 100% African American students.

The students volunteered to show me how the biodiesel refinery operated, and they methodically walked me through the process of creating biodiesel. Tom was a tall white student, and he wore crisp, pressed clothes. He walked in firm, long strides, exuding confidence as we
moved toward the barrel of oil. He started a detailed explanation of how the students in the club went about building the refinery. He spoke slowly and with a sense of assurance; I was confident he knew what he was talking about. Sue, an Asian American student, chimed in, explaining how the oil was changed into biodiesel fuel as it moved through the system. She pointed up toward the ceiling, to a series of tubes that connected a hot water heater, plastic canister, and a metal drum.

They described how they were able to use their fuel to do emission testing at the Illinois Department of Transportation (IDOT). In order to conduct the testing, David found a fellow teacher to volunteer a diesel-powered Volkswagen Jetta. They tell me that when they conducted the tests, their biodiesel fuel reduced emissions by 80%.

Later, David further explained the outcome of the students’ biodiesel fuel testing at IDOT, saying, “The results were overwhelming. The Jetta recorded an opacity value of about 22% in two separate tests running on diesel; whereas, they obtained average values of about 4% in four separate tests running on biodiesel they made from new and used cooking oil. That was about an 80% reduction in emissions.” The students and David displayed a shared sense of accomplishment when they spoke about the work they were doing.

The project went beyond building a refinery and included helping others learn about and begin using the biodiesel. Off to the side of the room, Jane and Li were working on a poster for an upcoming presentation about their club. As I looked at their poster, Li looked up and said, “We are going to help a rural school’s 4-H. They want to build a biodiesel processor, and we are going to show them how to do it.” Jane added, “We also are going to be donating the fuel that we create to a farm coop.” Li and Tom joined us, and Tom said, “We have even been teaching graduate students here at UIC how to make biodiesel. That’s pretty cool.” He had a
sense of pride that they were teaching students who were older and more advanced in their studies. In addition to their teaching other students, the students in the club had developed videos on how to create biofuel and put them on the Internet. They felt that by creating the videos they could reach a larger audience and get other students interested in what biodiesel fuel could do for the environment.

By January 2011, David and his students had partnered with a vocational school in the city and a rural high school, and his students were teaching the students at those two schools how to build their own biodiesel refineries. The rural school’s Future Farmers of America (FFA) organization expressed a deep interest into the work being done through this club. To help the FFA get their own system up and running, the students worked to raise enough money and resources and then donated a biodiesel system to the rural school. For David and his students, one significant aspect of their club was the desire to go out and share what they were learning with others.

The club became more and more organized and developed a shared identity. The club established a mission of “helping to engender renewable organic energy sources.” And the group’s website provided their shared vision of what they planned to do in the future,

We started working with a nonprofit group called Food Desert Action (FDA) that has an old CTA bus. The plan is to rehab the bus into a grocery store on wheels so that the FDA can drive to food deserts around the city and offer residents fresh and organic produce to buy. We have been donating a lot of labor in removing unnecessary equipment. We also produced 300 gallons of biodiesel to donate to the group to reduce emissions and offset fuel costs. Lastly, we had a
fundraiser in which we raised $525 to donate towards the purchase of solar panels for the bus.

By that spring, Jane had contacted the Chicago Museum of Science and Industry many times, promoting the refinery the students had built. After her many attempts, museum officials invited the students to build a museum display that showcased the work that they had been doing. The opportunity to have an exhibit at the museum was a first for a high school after-school club. The exhibit remained in place between January and February of 2011. A newscast on Chicago’s ABC News Channel covered the exhibit, and the author distinguished these young people who were committed to actively working on an environmental issue from other young people who were occupied with their electronic devices and video games.

**Animating students to lead and teach.** For David, it was important to involve the biodiesel club members in all aspects of the project: building, preparing chemicals, marketing, writing, and networking. The active involvement was central to club members learning and gaining expertise on the process of making biodiesel. “I want everybody to be able to do the grunt work, to try and make connections, to learn how to collect oil; everybody should have a part in fabricating. Some kids naturally drift quicker to tools than others, but they should all have a part in all aspects. They should know the whole process, and everybody learns the whole process and can explain it to others.” As the project unfolded, students identified roles that they felt matched their own interests and benefitted the club. David explained, “Some gravitate to do the titration, the testing for pH of the oil. Other kids are happy mixing the chemicals. Other kids want to do the filtering process.” The roles that students gravitated toward extended beyond building the refinery and making biodiesel and included helping find resources, such as used cooking oil, and contacting area news outlets to promote the club.
The H.E.R.O.E.S. students put their web design skills to work and created a site on the school’s website featuring the club’s varying activities. The website included a blog written and maintained by biodiesel club members. I selected Jane’s blog entry to share as it shows how quickly David integrated a new member, someone who considers herself not a science person, into the group, but her blog entry also highlights how she was able to actively take on a leadership role that appealed to her:

**Why did I join HEROES?** Well, I was sitting in my history class in the middle of October, getting my notebook out and preparing to be bored to death. Li, a good friend of mine from freshman year, and who sits by me in history, asked if I would be interested in helping her out with her science fair project. Always glad to help a friend, I unwittingly replied, "Yeah sure. Why not?" The next day, Li and I went down to see Mr. Dressler, our faculty sponsor. I had never seen the man before, and was slightly unnerved when the tall redhead began talking technical with Li. He then turned to me and asked, "So, you ready?"

That was the beginning of my part in HEROES. I went into Mr. Dressler’s class that Friday, a little nervous and with no idea of what to expect. Tom, Cindy, and Mia, the other members of the team, were quick to welcome me, and Mr. Dressler put me straight to work. Basically, my job was finding restaurants in the Tri-Taylor area and giving the others numbers to call so we could receive used oil to convert to biodiesel. I also was charged with writing down the names of all restaurants that were willing to help us out, the name of the manager, and dates and times to pick up the oil. It's been a long and hard trek from those simple days.
Now, I’m our self-proclaimed Media Expert. My job is now to contact local news broadcasting services (newspapers, radio stations, and television stations) and to organize interviews. I’m also looking into farming coops and local museums that might be interested in displaying a model of our system.

Though I’m not at all a science person, I love coming to the lab every Thursday, Friday, and Saturday or Sunday. Everyone is so kind and amusing; the grad students in charge with the lab are some of the funniest guys I’ve met in a while. I’m right in my element. Writing, reading, and contacting people is something I enjoy. I’ve also had a lot of “firsts” with HEROES. I used my first power drills, built my first biodiesel refinery, and was interviewed for the first time.

Jane demonstrated that she was actively involved in all aspects of the project, but that she most enjoyed the networking aspect. Her hard work reaching out to museums paid off for the H.E.R.O.E.S. Club. In the spring, David’s biodiesel club was invited to exhibit their biodiesel system at the Chicago Museum of Science and Industry. The skills students were gaining connected to science, but they were also learning skills of how to lead projects that get results. The opportunity to have an exhibit at the museum was a first for a high school after-school club. Shortly after the exhibit closed, the Chicago Public Schools announced that it would reduce its teaching force, and many of the cuts focused on reducing staffing at their specialized schools, including the magnet schools. David, a nontenured teacher, became one of the teachers let go. Again, David went in search of a new school.

**Turning a green roof into beautification project at Riverside.** In the fall of 2011, David took a position at Riverside High School and returned to teaching physics. David, working with his Riverside students to generate a project idea, had written and secured a grant to
build a green roof at Riverside. Although he had a positive performance review from his administrators for his teaching, in the spring, the school district announced that they needed to reduce their teaching force. David, one of the newest members of the Riverside faculty, once again faced the loss of his teaching position. Similar to what happened to David at Townsend and Magnet, the setting of this school too, emerged as a tough environment for David, a nontenured teacher, to build sustainable after-school initiatives. Although David’s time at Riverside was coming to an end, he continued to look for ways to create learning opportunities for his students beyond the classroom until the end of the school year. The following vignette illustrates the actions that David took even when faced with difficulty: (a) responding to difficulties and (b) finding supportive administrators helps, but may not be enough.

**Vignette 5.2: Responding to difficulties and gaining administrator support, David’s physics classroom, Riverside, April 23, 2012, 7:30 a.m.** At the front of David’s classroom was a flier advertising a grant contest. David saw me looking at the description. “I was able to get that grant. Our goal was to build a green roof here at Riverside.” The students at Riverside felt building a green roof would be something “cool”; David wrote the grant and was awarded a $5,000 grant. The students and he had planned to begin the green roof during the 2012–2013 school year. It was April 23, 2012, and the end of the school year was a month away. The Riverside District was in the middle of making cuts to the teaching force, and David found out that he was one of those being cut. If he and his students did not find a way to use the money prior to the end of the school year, the money needed to be returned. David decided to bring this dilemma up to his first-hour class.

After the morning announcements finished, David went to the front of the room and held up a piece of paper, "There is $5,000 in this grant. As you know, I'm leaving, but I still want to
do something with this before I go. I’m thinking about doing a ‘Beautify Riverside Day.’” With only a month left in the school year, David knew there was not enough time to build a green roof. They needed a project that was manageable and still connected to science and the environment, as he didn’t want the funds to be returned and to go unused. He and his students decided there was enough time to build a flower garden, improve the existing landscape, and give the students a chance to make a difference at the school. David wanted as many students to participate in the project as possible, so he tied the after-school work that would be needed to earning additional class credit in his courses. He told the students, “We would plant flowers. I want as many people here as possible, so I would give board problems.” In David’s classes, he provided “board problem” points for those students who offered up an explanation to how they went about solving assigned homework problems. The board problems were not extra credit; rather, the students were expected to participate in the class by providing not only an answer to a problem but also an explanation of how they arrived at the answer. These board problems were highly coveted by the students; during the observed class periods, students’ hands shot up so that they could be first to answer and explain some of the tougher problems on their physics homework.

Chanti, the principal’s daughter, was sitting in the second row. She sat up straight, turned to the person next to her, and said, “This would be good.” The students began to move in their seats and talked with one another quietly and with excitement. They were interested.

David regained their attention, “Okay, we will plant some flowers. We want flowers and plants that will stay. Do you know what a perennial or annual is?”

Only one student raised his hand, “My grandma gardens. The perennial will come back year after year. The annual won’t.”
“That’s right. There are plenty of perennials that are native to Illinois,” David paused. “I would buy the supplies, we would feed you. I can bring a truck, we can rent a trailer, we might be able to go buy supplies. I would need permission slips. You could design the flower beds.” It’s the end of April, and this project would need to be done by May 23, the last day of school. After some discussion, the students and David decided upon Saturday, May 12. He said, "I think we need to get a planning team together. We could look up some images on the internet to figure out what flowers we want to plant. So, if you can't do the work on the Saturday, then you can come in and help plan before or after school."

After the class ended, I asked David about his experience teaching at Riverside. “The principal here is great. She evaluated me a few weeks ago, and I got an outstanding evaluation. She is very supportive of me, and that makes it great. I took 71 students to the Engineering Department at University of Illinois, and she liked that.”

I paused as I wanted to ensure that I heard the right number. “Did you say 71?”

“Seventy-one. That’s a lot isn’t it?” Riverside had a population of approximately 500 juniors and seniors, so that meant that 14% of upperclassmen had now visited UIUC’s campus and the engineering department.

**Responding to difficulties.** Although David knew he would not be returning to Riverside and the green roof project would no longer be possible, he was still committed to completing a project that he and his Riverside students had started. In order to complete the project with a shortened timeline, David brainstormed with his students to create a more manageable project that could work during the last 30 days of school.

On May 11, 2012, I returned to Riverside and observed the beautification project unfold over the course of Friday May 11 and Saturday, May 12. During the beautification days, the
students rebuilt two large planters inside the school, built two new flowerbeds outside, built a trellis, and restored the landscaping that lined the front of the school. Fifteen students stayed after school on Friday and traveled to the nursery (located 20 miles from the school) to pick out the plants and flowers for planting. On the rainy Saturday morning, 25 students arrived to finish the beautification project. When the day was done, the flowerbeds were finished, and the front of the school had a future of bright, colorful flowers. Prior to students leaving, David asked that they gather around the newly built trellis for a photo. The students came together closer and closer so they all fit in the photo, and the photo captured this memory of the beautification process at Riverside and David’s commitment to these students.

Figure 5.2. Riverside students who participated in the beautification project gather around the newly built trellis and planter at the front of their school.

Over the course of the three different school settings, David faced difficulties. Each time, he was able to press forward and find solutions. At Townsend, David was able to partner with a private school to ensure that the biodiesel and solar panel project continued on in order to provide electricity to a Haitian school. With the magnet school, David found outside space that would accommodate the students in building a biodiesel refinery when space wasn’t available at
the magnet school. Even with the loss of his position at Riverside, David continued on to find a different project that would work prior to him leaving the school.

*Finding administrator support and still facing mandated school cuts focused on time in service.* During the beautification project, David and I met the principal in the hallway as we were headed outside. She had a warm expression on her face and smiled at David, “Were you surprised?” David explained later the principal had worked with the students to throw him a going away party. David responded, “I was. I had no idea.” She told him, “They were so excited. They really will miss you.” David said that the principal had expressed her concern and desire for him to stay at the school to the district office, but the district office was following the new guidelines for reducing the teaching force. David had earned the principal’s accolades in several ways. David had made the arrangements for and had taken over 70 students to visit UIUC’s Engineering Department, the principal had seen David teaching on several occasions, and her daughter was an active member in the after-school science activities and tutoring that David led. David was grateful to have her support and recognition, but in the end, the support of his principal was not enough for him to stay at Riverside.

In the Riverside District, the individual school’s administration had little say regarding which teachers stayed and which received pink slips. David had received an excellent evaluation from his principal, and the principal would have liked for him to stay. Prior to the 2012 Riverside reduction in teaching force, Illinois Senate Bill 7 (SB7) passed on April 14, 2011. The district used this bill to determine the teachers who received pink slips. SB7 provided the following Reduction in Force Policy for teachers outside of Chicago, as outlined in the Illinois Education Association’s SB7 Fact Sheet:

Effective immediately upon passage, a complex system of “performance tiers”
will be established that:

- First, establishes categories of teaching positions, as is currently done under existing law;
- Second, places teachers in each category who have the required certifications and qualifications;
- Third, places teachers in each category into one of four groups, or “performance tiers,” which are defined based upon tenured status and varying levels of performance ratings.
- Finally, ranks teachers within each category by seniority.

Although David received an “excellent” performance review at Riverside, he was a first-year teacher in the district, and he was first to go. Excellent evaluations for nontenured teachers were not factors for Riverside teachers; there were not enough tenured teachers who had been evaluated within the last three years, so the newest teachers in the district were still the first to go. The extra work teachers do for students beyond the school day is not part of the formula outlined by the state legislation.

The Settings of Three Low-Income, Urban High Schools

In each of the high schools, David challenged students to use the physics and science concepts learned in class and apply the concepts to the world beyond the walls of the school. His transitions from one school to the next became an important story within the case. All three urban high schools were located within Cook County and within or near the city of Chicago. As the third largest city in the United States and with a dense population, the majority of schools within Cook County are considered urban. In 2012, the population of the county was 5.2 million people, included 40% of the state’s population, and was the most heavily populated county in the
state (U.S. Census Bureau Quickfacts, 2010). Within the county, the Chicago Public School (Unit 299) district served students living within the city limits of Chicago. Those students living outside the city limits attended one of the 148 different public school districts situated within the outlying communities. During the course of the case, David taught in two different county schools and one city school. All of the schools in which David taught were considered urban schools and are described in the following table.
When looking at the demographics of three different school settings and in comparison to other schools in the state, the two county schools served a higher proportion of students coming from low-income households (the average state low-income enrollment between 2009 and 2011 was 48%–49%). The percentage of low-income students within the magnet school was 10% lower than the state average. All three schools served a higher percentage of minority students when compared to other public schools in the state (state average of minority students enrolled in schools was between 39% and 41% between 2009 and 2011). In terms of standardized testing, the magnet school was recognized for its academic achievement while the two county schools

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11 All schools were given pseudonyms. Data within this table were taken from Northern Illinois Interactive Report card. School size, low-income student average, adequate yearly progress, and demographic data were retrieved for the year corresponding to when David taught at the schools.
were identified as schools in need of improvement. While the settings did not define the opportunities, they did present what others have indicated difficult contexts for fostering innovative learning opportunities (Payne, 2010).

**Failing at, Tinkering With, and Teaching Science: David’s Background and Sense of Care**

David’s connection to math and physics did not begin in high school. David explained that he failed the first quarter of algebra in high school, and he never took physics. David’s school experience with science and math was not a good indicator of his future with science; however, his physical exploration had a strong connection to his path to becoming an engineer. When David was a high school student, his family had an old barn in their backyard. The barn, built in the 1950s, was a compilation of old scrap lumber and wood from railroad cars. The barn had a dirt floor, and David decided that the old barn needed a real floor. Armed with only his desire to build, David set out to raise the barn. He went about bracing the barn as he had seen someone else do on television. David borrowed jacks from neighbors and raised the barn. He located used or discarded flooring materials, added the floor, and lowered the barn back down. This endeavor was completed on his own and through knowledge he gained as he went through the process. His father gave permission to fix the floor, but he had not anticipated the amount of work that David was undertaking.

When David left high school, he felt ill prepared for college and took a couple years off school and worked. He learned that he could earn a nondestructive testing certification through the junior college, and he thought that might be a good opportunity to increase his pay and job prospects. “I started out in the lowest math class in the junior college. In high school, nobody ever pushed me, nobody cared if I pushed myself.” During the junior college course, David explained, “Everything started clicking. The teacher said, ‘You’re doing excellent.’ I had to
work and teach myself.” In his subsequent math classes, David excelled. He went onto calculus, and then was accepted into the UIC engineering program.

After completing college and prior to becoming a teacher, David spent four years as mechanical engineer for a large oil company. The oil company announced that it would be closing portions of its Chicago operations and relocating their engineering department to Texas. Rather than relocating and leaving the Chicago area, David accepted a severance package and returned to school to pursue a master of science in mechanical engineering. Growing up just outside of Chicago and living just down the street from his aging parents, David had no intentions of leaving the area. During his second year in the program, David became a teaching assistant for a fluid dynamics class. He realized at that point he wanted to become a teacher. “I felt empowered helping students, so I started a program to become a teacher while still finishing my MSME degree. In the spring of 1998, I graduated from UIC with an MSME and from Elmhurst College with a bachelor of arts in teaching. Two colleges in one semester.” He obtained certification in math, physics, and chemistry.

David identified with the students who struggle with math and physics in high school. With his past experience in mind, he told me, “I refuse to let anybody say they can’t do it. I failed algebra; I never took physics, but I became an engineer.”

Building upon his own past experiences as a struggling student at the high school level, David wanted to do things differently in his classroom. “By the time I got out of my high school, I realized my high school did not care at all about what I learned. I felt that they barely knew I was a student there.” David felt in order to get students to care about science and math he needed to “spark their interest,” and he was “willing to spend the time to help students learn even when they don’t think they can do it.”
When working with students inside and outside of the classroom, David demonstrated this sense of caring. He seemed to have an acute awareness to the students and their needs. When a problem arose, David handled the issue with patience and a sense of humor. He also expressed a desire to work harder with those who seemed to be struggling.

_I care about my students who are failing, the most. My students that are A, B, and C, they’re doing well. I mean I enjoy that, but I like it when a kid who is failing—which just recently I had a student who is pregnant—she was failing. I worked with her hard enough and encouraged her and she got a C at the end of the third quarter, so I care more about the kids who are failing. I get a lot of delight and enjoyment and satisfaction actually in students who are failing and end up turning it around._

David noticed if something was troubling his students, and he responded. The following vignette focuses on David’s caring approach with students.

**Vignette 5.3: Caring for Students, Honors Physics, Townsend High School, March 17, 2010.** David had been teaching for 10 minutes, and a female student walked into the classroom with late with a pass. Her head was down and she seemed to be watching her own feet as they slowly made their way into the classroom. Her frown made it clear she was not feeling well. David asked, “Are you okay?” She explained that she had been in the nurse’s office. She immediately took her seat, crossed her arms on her desk, slid down into her chair, and gingerly laid her head down upon her arms. David approached her desk, knelt down, and quietly asked, “Are you sure you are okay?” She slowly picked her head up and looked at him, her eyes looked tired, “I was at the nurse’s office over lunch, so I didn’t eat.”

“Do you want some popcorn?” he asked.
Without hesitation, she said, “Sure.”

David went into the office that was connected to his classroom. I listened to the sound of the microwave door open and close, the hum of the microwave at work, and the popping of popcorn. David stood at the door looking out onto his class. The buzzer sounded, he turned back into his office, the smell of popcorn wafted into the classroom. David came back with a full bag of popcorn. She got up out of her seat and walked toward David, and he handed the opened bag to her. She immediately began eating the popcorn. After a few handfuls, she reached into her backpack and got out her work. Before class ended, she volunteered to help solve one of the class problems.

First period physics, Riverside High School, 8:20 a.m., April 23, 2012. The bell rang and the morning announcements blared through the loud speaker. Covering the speaker were two large pieces of Styrofoam held in place with blue painters’ tape. As I took a photo of the device, David noticed and moved alongside me. “Yea, for some reasons the volume on the announcements is way too loud. I tried to get the office to change the volume, but they couldn’t figure it out. Kids were covering their ears, so I just made something so it wasn’t quite so loud. It might not be the greatest aesthetically, but it helps. It is still loud. The great thing is that I can use this to demonstrate sound waves.”
Figure 5.3. David built a sound-dampening device for his classroom speaker students felt was too loud.

The sound buffer shown in Figure 5.3 is an artifact of David’s caring approach to teaching, but the buffer also shows David kept his engineering roots and continued to look for opportunities to use physics to build, design, and problem solve in the classroom. David wanted students to see themselves as capable of doing math and science, but he also wanted them to apply the concepts they were learning to the world around them. He felt that building and using his hands was essential to his own appreciation for physics. “I love to tinker. I always want to be building things. I have built tree forts, I love being outside, and I like to be doing things with my hands.” David explained why he brought in the outside projects and experiences to teaching physics. “I want to make school a little bit more interesting. I try to do things a little different and unusual. If I just showed up and taught everyday [without bringing in the real-world examples and doing the outside of school projects], it would be boring.”

During an interview, I asked him to reflect upon his past projects and comment on how he was able to get students to follow him. His response was not based upon his past experiences or approaches about getting students to follow him; rather, he transitioned to talking about the
ideas his students at his present school were generating and how they might accomplish creating the projects. In the coming weeks, David and the students were making plans to participate at the pep assembly by building potato cannons but using foam balls. David’s background connected to his ability to build the projects he pursued; however, David preferred to talk about his future endeavors working with students and it was the projects that drew the students into spending time on science after school.

Experiential Learning During Class: Practical Applications and Future Preparations

Over the course of this study, I observed David before and after school, during his classes, and during the biodiesel and beautification activities. In the varying contexts, David provided students with experiences that connected with being a reform-minded science teacher and experiences intended to increase students’ interest and appreciation for science and reinforce the science concepts David taught. This section is intended to examine the different experiential learning opportunities that David provided for his students during class, before and after school, and during his after-school science initiatives.

David’s classroom was markedly different from other low-income school classrooms I had observed and worked within. It featured a bright atmosphere and was decorated by his students’ artwork and projects. It had laptops, a SMART Board, visual aids, lab equipment, and an organized, clean environment. Much of the technology David had in his classroom was purchased through the grant money he earned. David’s expectations of his students were the same as (and in some cases higher than) what one would find in an upscale suburban school: high demand for acquiring physics knowledge and the expectation that all students should continue their education after graduation. When he was teaching, David asked his students to take an active role in the classroom; he provided visual, practical applications of the concepts
they were learning, and he wanted them to see that what they were doing in class tied to their future education. The students responded: They worked hard, they paid attention, and they took their presentations seriously, but they also seemed to enjoy his class.

**Vignette 5.4: Experiential learning in the classroom, Advanced Placement Physics, March 17, 2010, 11:45 a.m.** David’s planning period ended, and his AP physics students arrived for class. As soon as the bell rang, David pulled the door and began class. The quick start to the period meant that being on time and ready were central expectations. David’s students had prepared presentations for today’s class, created force and distance scenarios, and included their force and distance calculations using two posters.

A group of two female and two male students went to the front of the room, where they placed two large posters. One poster featured a drawing of a stick figure standing at the bottom of a hill. At the top of the hill was a rock getting ready to roll down the hill. A label next to the stick figure said, “Britney Spears.” The first student began the presentation. “Our scenario is this: At the bottom of the hill is Britney Spears.” He pointed to the stick figure’s blond hair. The students laughed. “Now, at the top of the hill we have this rock that weighs this.” He used the pointer and pointed to the calculations. “What we are trying to find out is if the rock rolls down the hill at this speed, at what force will the rock hit Miss Spears.” The next student took the lead and walked the class through the calculations.

The other groups followed. Within each presentation, all of the students took a portion, and they all participated. David explained he not only wanted students to demonstrate what they knew through formal ways such as assignments and tests, but he also wanted them to be able to stand at the front of the room, explain the concept, and practice their presentation skills.
At the end of one of the presentations, David offered praise but raised an issue with the calculations. “Does anyone see an issue with their calculations?” There was a pause as the students studied the problem. One person offered with some uncertainty, “Is it the grams?” David latched on, “Yes, what’s wrong with the grams?” Another student said, “It looks like the decimal is off.”

David moved quickly to the front. “Yes, and moving your decimal accidentally is a common mistake.” He went into his attached office and came back to the front of the room carrying a large weight. “They were working with a pebble, right?” The students nodded; all eyes were on him as he carried the heavy weight. “This weight reflects how their pebble has suddenly transformed into this huge weight. It is important to not only do the math but to also look at the problem from a realistic point of view. The grams they have in their problem are way too heavy given their original problem. If you think through it logically, you will be able to spot problems.” He passed the weight around. The students took turns holding on to the weight. Several were surprised by how heavy it was, and twice it nearly dropped to the floor. He once again offered praise to the team for their presentation.

During the course of the class, David quickly introduced me. “This is Ms. Koehler, and she is here from University of Illinois. She is observing us today.” Prompted by the introduction, a young woman approached me after class. She opened her physics folder and handed over her acceptance letter to University of Florida engineering department. She was excited as she told me, “I want to be an engineer. I didn’t even think about being an engineer until I took Mr. Dressler’s class. He’s always here, and he wants us to do well.”

After she left, David asked, “Did she tell you about where she is going to college?” I nodded. “It’s really important to me that these kids think about their college options. One of my
class requirements is that they complete a college application. This can be a community college, a four-year college, or a vocational school. It doesn’t matter what the next step is; they just need to be thinking about what that is.”

Physics, March 17, 2010, 12:40 p.m. The next hour students arrived for class. This class was also physics but was not an AP course. Once the bell rang, David asked the students to each take a laptop from the back of the room. Within the first five minutes, all students were logged in and had pulled up their physics problems from the night before. “Let’s go over the problems that were the toughest for you. Which one should we start with?” A young woman said, “Number seven.”

“Ahh, the circumference one.” David went back into his office and returned with an airplane on a string. He attached the string to a ceiling tile with a paperclip. He gave the plane a gentle push, and the plane whirred overhead in a circle. The plane continued in the circle as he explained the problem.

He moved to the SMART Board, picked up the electronic pen, and began to work through the calculations. Along the way, he asked questions: “What’s next?” “What did you find the answer to be?” The students provided the equations, and as a class, they worked together on the different calculations.

As the students answered questions, David kept track of their involvement and gave them board problems. For the next question, he prefaced it with, ”Do I have any mathletes in here? Now, I want to tell you that I have a former student who never thought she could do this stuff. She is now in the electrical engineering program at U of I. She taught her TA how to do this in one of her classes.”
With this introduction, several students sat taller in their seats. He asked the question, and five hands shot into the air. Drew went to the board and showed how to complete the equation. David motivated his students through encouragement but by also connecting their present learning with future success.

As I looked around the room, I saw all 25 students were working, their pens and pencils made adjustments to their answers. David had their deep attention with what I considered to be a difficult physics problem. When the bell rang, David took the plane down. As the students shuffled out, he turned to me with the plane in hand. “I saw this at a flea market and knew I had to have it. It was so cheap, but it provides such a good visual. I like finding things. Where others see trash, I see possibility.” He carried the plane back to his office.

Experiential Learning Before and After School: Reinforcing School Science

When it came to his teaching day, David arrived early and stayed late. He felt learning science demanded a commitment from both he and the students beyond what happened in class. Learning physics, David believed, required a lot of practice, and he made himself available to students so that he could help them through the process of learning. “Science isn’t necessarily something that is easy, but everybody can do it as long as I get them to believe that they can.” He typically averaged between 5 and 10 students before school and up to 25 students after school. “I’m here to help them as they figure the problems out. There is something to be said about a teacher and a class that challenges them to work hard.”

During the times before and after school, David could spend more time providing students with active, reform-minded learning experiences. “After school, I can focus on taking what we are learning in class and providing more hands-on application. I help them, but then they start to get it on their own, and soon they’re solving problems without my help.” David
believed his time before and after school helped students to gain confidence in their ability to solve science problems and, in the end, helped them to become self-sufficient. The following vignette shows the teaching that David did beyond the classroom and provides an example of David giving a student a physical experience to help reinforce a scientific concept being taught and encouraging the student to teach his peers what has been learned.

**Vignette 5.5: Experiential learning before the school day, David’s physics classroom, Riverside, April 23, 2012, 7:00 a.m.** I arrived at the school at 7 a.m., an hour and 20 minutes before the start of the school day. When I arrived the school hallways were still dark, and there was no one at the security desk. I followed the signs to the front office and found the lead secretary in the hallway. She could tell I was looking for something “Can I help you?” she asked.

“I’m looking for Mr. Dressler.”

“I don’t know if he is here yet.”

A female student who overheard our conversation interjected, “Oh, Mr. Dressler. He’s here. He’s always here.” She turned to the secretary and said, “I’ll show her his room.” The secretary was happy for the student’s help. “Okay, great.”

I followed the student. She had a stack of books in her hands. I asked, “Do you have Mr. Dressler as a teacher?”

“No, I wish. He is always here. He helps his students. Sometimes, I go in and work on my homework in his room. He doesn’t mind.” She brought me to his room. Both sides of the hallway outside his door were lined with brightly colored posters from David’s physics’ classes. The posters included a visual representation of magnetism, examples of magnetism at work, and
a sample problem using magnetism. The walls outside of David’s classroom, unlike the other walls in the building, were covered with student projects.

Figure 5.4. Magnetic wave posters created by David’s students decorate the hallway leading to David’s classroom.

I entered David’s classroom, and he was at the computer preparing for class. I set my things down next to five tutoring sign-in sheets. Three of the sheets were completely full. “Are these the students who have come before and after school?”

Figure 5.5 David kept track of students through before- and after-school tutoring sheets.
“That is for the last week. I get here about 6:20 and leave around 5. That reminds me, I need to get these turned into the office. This is the nice part. The principal realized I was here before and after school tutoring kids. So, she told me to turn in the sign-in sheets, and she would give me a stipend. That’s been great.” He gathered up the sign-in sheets.

With a knock on David’s door, two students entered the room. One student arrived to make up an exam. The other student, Jamal, a junior AP physics student, arrived early for extra tutoring from David. The AP students took an exam on Friday, and Jamal was here early to look over the graded exam. After he finished looking through the exam, he asked David a question about a question he had gotten wrong about harmonic waves.

David said, “Come here, I think it would be easier to show you.” On Jamal’s exam, there was a one-dimensional drawing of a harmonic wave. To help Jamal visualize the process of the wave, David wanted Jamal to see the way in which harmonic waves move. Jamal followed David to the back of the room, and David walked to his office and returned carrying a device called a physics stand.

![Figure 5.6. David demonstrates harmonic waves before school with physics stand.](image)

David turned a few knobs, and the tight string started to shake. David asked, "Do you see the string is vibrating, that is the reverberation. Now, if we change the frequency . . .” David
turned the knob. “Harmonics are other frequencies that change the reverberations. Now, look at the string. Point to where the string is vibrating the most.” Jamal looked at it, and he pointed to three places. "Okay there are three harmonics. Those are the three antinodes."

David asked, "Now do you see where the string is almost still?" Jamal pointed to two spots. "Now, those are the nodes. That is the wave . . . the harmonics consist of nodes and antinodes."

David changed the knobs. "I changed the frequency, and now I screwed it up. See, you can see it vibrating, but it's almost flat. Do you hear how loud it is?" He moved the knobs again, and he had a third harmonic again. "Do you hear the difference?"

"It's quieter."

“That's right. When we get a good frequency and a good wave with the third harmonic, there is less interference, the wave is good, and it is much quieter. Just like tuning a radio. When you are not on the right frequency, you hear all that noise, that chchchch. But when you tune into the right frequency, you get the music crystal clear, this is the same idea."

David walked to the board and drew two different waves on the board and labeled them with numbers. Together, the two of them work out the calculations. Jamal erased the work on his exam and wrote the work from the board. “That makes a lot of sense,” he said.

Teresa entered the classroom. "Mr. Dressler are there any papers that I can hand out for you?" He responded, "Not yet, but I will have some a little later."

David turned to Jamal. "Do you want to show her?"

“Sure!” Jamal took Teresa over to the physics stand. The string was still vibrating.
Jamal asked, "Do you see where there is little movement here?" He pointed to where the string was still. "Okay, that is the node is. Now, do you see where the wave is at its highest?"

She nodded. Jamal said, "Now that is called the antinode."

Figure 5.7. Jamal teaches Teresa about harmonic waves.

He showed her the first, second, and third harmonics. As he was teaching her, she commented, "Oh that is so cool."

David came and stood next to me as he worked to get his materials ready for his first class of the day. He said, "Great, he has become the professor. My job is done." He smiled.

David moved toward Leon, the student who was taking the make up exam. He finished his last problem, picked it up from his desk, and handed his exam to David. David turned toward me and said, “Leon comes in for help.”

Leon responded, “You give us a lot of work to do, but you help us. It’s hard, but you work with us.”

David took the exam and turned to me. “I’d rather overchallenge them than underestimate them.” Leon smiled. “I’m definitely challenged, Mr. Dressler.”
Experiential Learning: The Importance of Outside Experiences With Science

In the classroom and with the projects, David knew not only the names of each of his students but he also knew how to pick out the tasks that kept them busy and engaged. During the beautification project, he brought enough tools for every student to have a role to play. He gathered garden tools from the school, his garage, friends, and neighbors to ensure that all hands were busy doing something. In the classroom and in these after-school projects, he kept things moving and left little space for idleness. He seemed to perpetuate this level of action by being busy himself, giving orders firmly but with kindness, and being very specific. It seemed natural that I had joined with the students in accepting directions and getting busy as it made me feel part of something meaningful. As I was conducting a final interview with David, I inquired about why students followed him as he pursued these science projects. David used the term pied piper.

The after-school biodiesel and beautification projects were open ended, and they emphasized problem solving. During these projects, the learning wasn’t always about science. Sometimes there were life learning lessons that unfolded, and David served as a guide along the way. The following vignette shows how David kept students active, but it also shows how he provided space for students to make mistakes with the help of a guide nearby. David used humor, action, and a sense of caring to draw students into the experiential, after-school science learning, and with 25 showing up for the beautification, his approach seemed to be effective.

Vignette 5.6: Keeping students active, Riverside Beautification, Riverside High School, May 12, 2012. David asked me to work with the students on the existing flower beds directly in front of the school, while he worked to get the fabric, planting soil, and mulch in place on the new flower beds. From 7:30 to 9:30 a.m., I worked with a group of 7 African American male students and shoveled mulch onto the old beds. As they shoveled, the students talked about
music. There was some disagreement as to whether or not Kanye’s new song was any good. There was talk about the colleges they were thinking about attending, and the University of Illinois was the number one choice for four of them. One wanted to stay local, and the other two were thinking of going out of state. They all expressed that they were nervous about the upcoming ACT and whether or not their scores would be high enough for acceptance.

The discussion about sports centered around Lebron James. As we talked and shoveled, the raindrops put a coat of dampness upon us. After a long period of shoveling, Jerome, a varsity football player who had stuck it out the entire morning, stopped for just a second, and said quietly to me, "I think it's about time for me to go have a seat."

At that moment, David was on the other side of the school with his back to us and was trying to put in a large hosta plant. David was beyond hearing range, and he was not looking our way. Just as Jerome finished the word “seat,” David called out, "Jerome, come here. I need you."

Jerome and I laughed at David’s timing. Jerome looked at me and said, "I don't know how he does that. It's like he has some kind of radar on inactivity." He laid his shovel against the bench and sprinted to David.

Riverside Beautification Project, nursery outside of town, May 11, 2012. As part of the beautification project, David, 15 students, a school maintenance worker, and I traveled to a nursery outside of town to select the flowers and plants to be planted. David drove a school van, and other students received permission from their parents to drive. We loaded the flowers into the van, the maintenance worker’s truck, and two of the students’ cars, and started to pull out of the parking lot. Sharice stood in the parking lot and waved at us to stop. David stopped the van and rolled down the window. Sharice leaned into the window toward David. Her voice was soft
and sweet, almost like a child talking to her father, as she said, “I was scared to tell you. I locked my keys in my truck. I already called my insurance and they are sending out someone to unlock it.”

David put his hand on his head, saying, “Geeezz, why didn’t you tell me?”

She looked down at the gravel parking lot and responded, “You can go ahead without me. They’ll be here soon.”

“No, no, no.” His voice was calm and warm. “We’re not doing that. I’m not leaving you here. Let me park the van.” He got out of the van, pulled his cell phone from his pocket, called the insurance company, and wrote down the cell number of the guy who was coming.

He called the number. “I just wanted to check and see how far out you are. Okay. Well, we are here with a group of high school students, so if you could get here as soon as possible that would be helpful.”

We stood outside the van. Sharice came up to David and said, “I’m thirsty. I think I need a drink of water.” He grinned and peered from the corner of his eyes with his arms crossed. “You need a drink of water?” He gently uncrossed his arms and patted her arm twice. “I feel like dunking you in some water.”

She laughed, “Oh, Mr. Dressler. I didn’t do it on purpose.” She patted him on his arm and smiled; it appeared the teasing made her feel better, and it lightened the mood.

After 15 minutes, the insurance company representative arrived and quickly unlocked the truck door. We were all hungry, so David stopped and treated us all to pizza in the small town before we got back on the interstate. On the way into the pizza place, David turned to me. “I bet you didn’t expect this. How will this work into your study?”

I responded, “This is all part of you doing things beyond classroom.”
“I guess you are right. It’s part of their learning. At least they do things like this now, when we are here to help . . . to protect them. Soon, they’ll be on their own.”

Navigating the Structures and Expectations of Schools to Achieve Results

David developed different learning opportunities for students within and beyond his classroom. The biodiesel and beautification projects did not fit into the standard routines of schooling. In order to succeed, David had to break from established structures and expectations. The break from routines and expectations was not always well accepted by peers or administrators. The following three vignettes focus on the three issues when it came to David’s projects and expectations. The first illustrates David finding ways within the system of schooling to accomplish his projects; it also illustrates how David was seen as a different kind of teacher by his students and how the work that he and his students were doing was not always welcomed by peer teachers.

Vignette 5.7: Getting students active and seeing a peer teacher’s reaction, 7th hour physics, Riverside High School. Seventh hour physics consisted mostly of juniors, and the juniors were attending a celebration for the upcoming Prairie State Exam. With only few students in his seventh-hour class, David decided it would be a good time to walk around the school and decide where to plant new flowers. As we made our way through the hallways, David was stopped by different teachers and a security officer who inquired about what we were doing in the halls. With each stop, David explained the beautification idea and that he had the approval of the principal. Outside of the main office, Keesha pointed to a large planter and said, “Mr. Dressler, I think we need something here.”

I bent down and felt the fake flowers and ivy. Nodding, David said, “It would be good to get some real plants in here and increase the oxygen level.”
Tamika added, “This looks so cheap.”

David responded, “We’ll get these redone with real plants.”

Figure 5.8. Students decide to replace artificial flowers with live plants outside the main office in Riverside.

Friday, May 11 11:00 a.m. I returned to Riverside and observed the Riverside Beautification Project in action. David’s class was being taught by a substitute. At 11:15, David came into his office, and I asked, “Were they able to get you a substitute to get things ready? Did your grant pay for that?” He responded, “No, I just used one of my sick days.”

On his way into school while using his sick day, David stopped by Menards to pick up a garden trellis for the students to build. As we talked, a maintenance man brought a large cart for David to use and told us the yard equipment was ready for us to use and in the shed outside.

For the next nine hours on Friday and five hours on Saturday, we would stay actively busy beautifying the school. After we retrieved the tools, David pulled four students from his class to help line the flowerbeds with plastic covering. He held a staple gun, and the four girls huddled around him. David said, “Okay, put the staples low enough so that the plastic doesn’t
show. Okay, so see how this staple might be a little high? You want to take the screwdriver and remove the staple like this.” He demonstrated how to use the staple gun and screwdriver. He handed the equipment over to Joy, a small Asian female student. He watched her remove a staple. She then carefully held the staple gun with two hands, and she put in a new staple.

“That’s right,” David offered praise. The noise and her success made her smile and say, “I like this.”

David needed to set up the other flowerbed, so he had me stay with this group.

“I’ve never used one of these before,” Tanya said as she tried the first staple. The staple didn’t go into the wood, and it fell into the bed. She tried again, and this time it went right into the wood. “Okay, I see what I need to do.”

![Figure 5.9. David demonstrates using a staple gun and then students take over.](image)

The girls worked together to finish putting in the plastic wrap. They didn’t need any help or guidance. “What do you think of Mr. David as a teacher? I asked.

Tanya responded, "He's better than all my other teachers. He's hard on us, and he pushes us to our limits. Most teachers don't do that to us."

The staple gun snapped another staple in as I asked, “Why do you think other teachers aren’t pushing you?”
Tanya didn’t hesitate. "I don't think they have the drive to."

Joy added, “I’m not sure they care.”

When the girls were finished, we headed outside to see what we could work on next. When we reached the stairs, a teacher stopped us and used a terse tone reflecting her annoyance and suspicion. "Where do you think you’re going? What are they doing?" The flash in her eyes was intimidating.

"They are potting real plants in the planters upstairs." I couldn’t recall the last time I had been spoken to in this manner.

She frowned and had a slight sneer. "Why are they doing that? There were already flowers in there."

"Yes, but they were artificial. They are going to put in real plants."

Her frown deepened. "Those weren't artificial. Those were real." The students stood behind me.

During the prior visit, when David and his students decided to place real flowers in the planters, I had leaned down and felt the artificial flowers. "No, I came through a couple weeks ago and looked at each of the plants. They were artificial."

She didn’t like that I had challenged her. "Well, they were real last year."

I conceded, "That could be. Maybe they died and someone put in artificial." Although I offered the concession, the layer of dust indicated their presence had been for longer than a year. The harshness of this exchange was small insight into the reaction some teachers have to student disruptions or involvement in activities outside of the norm within the school, and it matched David’s experiences when creating work that went beyond the standard expectations of teachers. Although the students were being quiet and working hard, the fact that they were not
inside a classroom seemed to disrupt the natural state of the school day. For the students, this was welcomed. For some teachers, the actions were suspect.

Figure 5.10. Riverside students complete the planter project. The artificial flowers have been replaced with live plants.

David brought intensity when it came to getting results with his projects. When Townsend administration had imposed rules that threatened the success of bringing electricity to the Haitian school, David moved much of the project to the private school that was dedicated to finishing the project. This intensity meant that David would not let difficulties stand in his way, and this level of focus toward a goal might be at odds with the goals of those in leadership positions. To help provide insight into this issue, the following vignette taken from David’s time in one of the EnLiST workshops is included. While the teachers of the course were not leaders, they do serve as authority figures in the setting of a classroom.

Vignette 5.8: Resisting conventions to deliver results, Entrepreneurial Leadership Workshop, UIUC, June 21, 2010. EnLiST grant participants gathered for a workshop about entrepreneurial leadership. The focus of the course was developing teachers’ entrepreneurial leadership skills in order to create innovative science learning experiences to students in their
classrooms, their schools, and beyond. During the morning presentations instructed by workshop professors, David was using his laptop. At the lunch break, the professors commented on David’s use of his laptop; he seemed distracted. At the afternoon break, I sat down next to David. He remained focused on his laptop and had decided not to take advantage of the break. I asked him, “So, what are you doing?” His eyes remained on his screen. “I’m trying to get the shipping and freight squared away for the solar panels to Haiti. I thought I had everything lined up but now there is a problem. Right now the panels are sitting in a harbor. Just sitting there. If I don’t get this figured out, the whole project is in jeopardy. I’m still paying attention, but it’s just that I have to get this done.”

While attending a workshop on entrepreneurial leading, David was working with the United Nations and other key players to get clearance to ship solar panels the students had built. He, working in conjunction with these students, would successfully bring electricity to a Haitian school for the first time.

David passionately pursued projects that went beyond the classroom and beyond the expectations of a teacher. As an untenured teacher, these projects were not considered when determining which teachers would stay in the event that cuts in staffing were required. In addition, these projects were not commonplace in schools, and the approaches he used were suspect by his peers and some administrators. David faced tremendous uncertainty throughout the three years of the study, and he went through three reductions in force. The consequences of David losing his teaching positions had consequences for his projects, but they also were felt by the students whom he had to leave. This vignette displays the impact felt by one of his students as David was preparing to leave Riverside.
Vignette 5.9: Surviving urban schools’ reductions in teaching force, Riverside

Beautification Project, Riverside High School, May 11, 2012, 2:00 p.m. Working alongside several students, I shoveled dirt into the newly built flowerbeds. I struck up a conversation with an African American junior student named Audrey. She told me that she had plans to go to college. She had a warm, bright smile, and she made quick work of shoveling even though she had on dressy heels and tight grey-denim jeans. She spoke of enjoying Mr. Dressler’s class. I said, “So, Mr. Dressler won’t return in the fall.”

This one statement triggered something for her. She shoved the tip of the shovel deep into the ground and looked at me and her eyes were fierce. “I just hate it. I don't even want to come back next year. All the teachers that I love and that care for me are being laid off. I have relationships with these teachers, and they are being transferred. I call him, ‘Uncle Dressler.’ He is the first teacher I have ever had like him. He cares, he makes us work hard, he believes in me. He wants me to succeed. He is the only one that does things like this. This is the first time that I have ever had the chance to do something like this. The Board of Education didn't do the right thing here. They didn't take the time to find those teachers who work hard for us so we work hard for them. They're getting rid of the people and things we need. How is this supposed to make things better?”

She spoke fast and with conviction. She took a deep breath; she told me, "I guess that’s been really bothering me. I actually feel better. That must have been a weight that I was carrying around with me. I feel better even though it won't fix it."

I talked with David about Riverside’s reduction in force. He had already been hired by another district in a community about 10 miles away. His next school served fewer minority students and fewer low-income students, and he was going to have a $5,000 increase in his
salary. He told me that if Riverside came back and decided to have him stay, he would. He had built relationships with the students that meant more than the salary.

David persevered to find another position in another district; however, the mourning of his students and their sense of loss highlighted the emotional damage of the revolving door of dedicated teachers within urban districts. Within low-income, urban schools, teacher turnover rates are high, and this constant reduction of teachers and then infusion of new replacement teachers creates an unstable environment for sustainable entrepreneurial efforts by untenured teachers. In this case, the cost of losing a teacher such as David, who brought in additional funding for science education, got students engaged in advanced science courses, and created science learning beyond the school day, seemed to be significant. David’s entrepreneurial efforts that gained him student admiration and national recognition did not provide added job security. One might argue that in a more affluent, economically sound school district, David may flourish, insulated from the economic strife of impoverished school budgets, but, then, he would not be bringing science learning opportunities to low-income, urban students, who, based on research, seem to be excluded and disengaged from science learning experiences.
Chapter 6: Discussion and Implications

Introduction

Prior entrepreneurial literature in the field of education has largely focused on corporatized models of education in the form of private or charter schools, and the emphasis of this body of entrepreneurial research has been on outside entities arriving in the educational marketplace to reform education (Hess, 2006; 2008). My hope was to build upon the limited research focused on teachers acting entrepreneurially in order to create new educational opportunities for their students (Chand & Misra, 2009; Williams, 2006). In this study, I identified science teachers who created new learning opportunities for their students and investigated the opportunities they created, the actions they took, and the support and forces they encountered. In this chapter, I will focus on the study’s three research questions:

1. What approaches did these teachers use to create new science learning opportunities for students?
2. What type of learning opportunities did these teachers create within and beyond their classrooms?
3. What sustained these teachers to pursue these activities? What forces did these teachers encounter that supported or impeded these activities?

As I investigated the cases and the actions of the teachers, I used the entrepreneurial literature as a lens to explore issues within the cases, drawing upon Chapters 4 and 5. The chapters discuss how Faith and David created new learning opportunities for students beyond the school day using entrepreneurial approaches and used new spaces for experiential science learning. The cases of Faith and David illustrate how teachers, using entrepreneurial approaches, are capable of creating new spaces for experiential learning in resource-lean contexts beyond the school. They
also point to the limits of these teachers and their opportunities. Faith and David identified students who would benefit from have learning experiences that allowed them to explore and problem solve using science. Interestingly, with the science experiences Faith and David created beyond the classroom, they encouraged students to ask questions, solve problems, and apply science beyond the classroom. These experiences differed from the learning experiences Faith and David were providing within their classrooms. The variation between the science learning happening within their classrooms and the learning experiences they created outside the classroom, I argue, may be tied to the institutional expectations, goals, and structures of schools. The institutional expectations of the schools, as outlined through educational policy programs such as NCLB and Race to the Top, are connected to performance on high-stakes tests. The specified learning outcomes for students tie directly to how well students perform on the exams, and thus the outcomes emphasize knowledge acquisition. These specific knowledge-acquisition aims of school often run counter to the aims associated with experiential learning.

In order to build experiential learning spaces, Faith and David used entrepreneurial approaches to move beyond their classrooms, and at times the institutional context of schools, to identify and sometimes create third spaces that were not completely tied to school nor completely tied to community. Rather, these were hybrid spaces where science learning, experience, and community overlapped, hybrid spaces where student interest grew and adequate resources were available. The entrepreneurial approaches Faith and David used required time and effort beyond the demands of the regular expectations of teaching. Their entrepreneurial endeavors created challenges as they attempted to bring new opportunities to students and connect with other schools and the community. To succeed, Faith and David seemed to embody a level of grit that allowed them to persevere in providing these opportunities for their students.
and to continue on with their goals over the course of the years of this study, even when faced with adversity. They effectively found areas of support from the greater community, including physical space, financial resources, marketing, and recognition. In turn, David and Faith’s students were able to give back to their communities.

The findings discussed in this chapter not only connect with prior scholarship around entrepreneurship and experiential learning but also extend the literature to emphasize that teachers using entrepreneurial approaches may identify resources and spaces within resource-lean contexts to provide experiential learning opportunities for students beyond the school day. This dissertation illustrates the following: (a) The creation of third spaces for learning can transcend the institutional constraints of school and connect science learning to the community. (b) Entrepreneurial approaches can be used to identify and create the spaces. (c) Experiential learning attracts students to new, relevant science learning beyond the classroom. (d) The mechanisms of support, the nature of grit, and the act of perseverance help overcome difficulties. The following figure is a visual representation of the flow of Chapter 6 and includes the topics corresponding with the central research questions. The figure is not intended to represent a process or step-by-step diagram of the teachers’ actions but to frame the flow of the chapter.
Figure 6.1. A conceptual overview of chapter six provides the flow of key topics.

The cases and subsequent findings raise issues related to entrepreneurial teachers who provide innovative learning opportunities for their students as well as further research on innovative, experiential learning spaces. Institutional contexts of low-income schools failing to meet the expectations of the state and federal education system provide contexts in which teachers might find more support for innovation beyond the walls of the schools. Both of the teachers profiled in the cases pursued opportunities beyond their classrooms and schools. This may be attributed to the school’s main focus being on complying with the specified learning outcomes and improving overall performance on high-stake tests rather than providing students with innovative learning experiences. Although the teachers in the cases went beyond the setting of schools, I do not argue that entrepreneurial teachers must go outside of schools to create innovative learning opportunities; however, teachers may find additional support and flexibility by doing so.

The findings indicate that teachers, acting entrepreneurially, can create innovative learning spaces, find support from the outside community to create these educational opportunities for students, and contribute to the community through the creation of the learning
experiences. The increased workload and administrative constraints for teachers gives caution for entrepreneurial teachers creating new experiential learning opportunities that go beyond the current structures of school. Through entrepreneurial efforts, teachers may develop third spaces where education and community coexist and there is adequate flexibility for experiential learning and innovative learning opportunities for students.

Third Spaces as Places to Connect Educational Science With Community

David and Faith established different spaces for students to learn science in addition to the experiences they were gaining within the classroom and school. The creation of a third space, not solely school nor solely community, was a hybrid space in which the expected institutional nature of learning was absent and a model for learning co-created with their students was established. The spaces in which we, as social creatures, operate are often defined by purpose, function, culture, and location. The school provides a defined space in which roles are clearly delineated: teacher, principal, student, custodian, secretary, and so on. David and Faith sought to define a new space in which those roles were changed and the emphasis on learning altered from acquiring scientific knowledge to gaining active experiences with science.

In their own teaching and classrooms, Faith and David determined the classroom teaching and subsequent learning was not addressing the students’ expressed discontent and disenfranchised experience with science. In recognition of a teaching and learning deficiency within the classroom, they developed “strategies of resistance” through the development of learning opportunities that did not mirror school science. In order to address the learning needs, Faith and David created alternative spaces for students to come to science learning. To quietly resist without causing too much conflict, they went beyond the structures and controls of schools. For Bhaba, this ability to continue to align with the dominant authority but to also do something
different and break free from traditions, routines, and structures is called “sly civility” (pp. 132-144). Faith and David accepted rules, structures within school but created something outside the bounds of control. Within their schools and classrooms, they aligned with the accepted teaching practices, but they did not accept that the manner of teaching was adequate for addressing the interests and providing the necessary opportunities for students. Faith and David created spaces after school within which students could drop the identity of student, move past the hierarchy of student/teacher, and begin to take on leadership roles associated with experiential learning.

In most of these spaces where students could attend voluntarily, based upon their own interest and desire in participating, the learning operated outside of school and existed in a space that was neither community nor school. Bhaba says, “As literary creatures and political animals we ought to concern ourselves with the understanding of human action and the social world as a moment when something is beyond control but not beyond accommodation” (pp. 17-18). Faith and David recognized and acted upon the expectation that the curriculum within their classrooms aligned with the school and district curriculums, and the subsequent tests that are inherent within the structure of schooling. The institution of schooling and their teaching within their classroom was to some extent beyond their control; however, both believed that there was a type of science learning that was missing within their classrooms, and the missing experience of science as an active endeavor warranted accommodations. It was these accommodations that were within their control if they created new science learning opportunities for students beyond the setting of schools. They sought to build new social settings in which students could experience science. Within these third spaces, science became action rather than the accumulation of facts, figures, and laws. For Faith, the emphasis of the learning was transitioning the teaching of science for her high school students so that they were able to lead science camps for younger students at
local community centers. For David, the emphasis was on problem solving through science
during an after-school program that focused on creating and testing alternative energy sources.

Within these new spaces for science learning, the traditional expectations of teacher and
student were blurred. In the traditional classroom, imposed knowledge boundaries were present.
These boundaries aligned with the high-stakes tests which define the scientific knowledge
worthy of study within schools. This demand for knowledge acquisition provided an
environment of complacency, and repressed reform-minded science teaching and learning. Faith
and David, as teachers and learners in the third spaces they created, were able to create co-
constructed exploration activities with students. The goal of the science camps and the
alternative energy after-school organizations was not to achieve a set of fixed learning outcomes
but rather to share the collective experience of engaging in scientific activity. The creation of
third spaces, for David, presented some significant issues when working within the context of
Townsend. The increased community interest and large donations for the school meant that the
space that he created still fell under the authority of school leadership, and this created a level of
tension that ultimately impacted his ability to stay at the school when there was a reduction in
force. The creation of third spaces may have the opportunity to create dynamic, valuable
learning opportunities for students, but the structures and institution of schooling may continue
to act with a level of authority and ownership over such spaces even when the spaces fall outside
the school day and classroom.

In addition to the traditional classroom space and the beyond-school third spaces, there
were also intermediary spaces that Faith and David created for students through the Science
Road Show and the School Beautification Project. Within these intermediary spaces, David and
Faith were still operating within the school, but they and their students were reaching outside the
classroom. I developed a conceptualization of experiential spaces for learning based upon the case studies as shown in the following figure.

Figure 6.2. An interpretive summary of the experiential spaces for learning present within the case studies.

**Entrepreneurial Action for Experiential Learning**

As described in this study, Faith and David taught science within resource-lean contexts and recognized that their students needed different learning opportunities than what was being offered in their science classrooms. To create reform-minded science learning in these resource-lean settings, David and Faith applied entrepreneurial approaches that included (a) creating
learning opportunities based upon student interaction and tied to prior experience, (b) developing reform-minded science teaching and experiential learning beyond the established curriculum, (c) employing bricolage behaviors to fund and support science learning, and (4) animating students to lead and in turn animate others.

**Creating learning opportunities based upon student interaction and tied to prior experience.** Faith and David actively interacted with their students, and through these interactions, they recognized students needed to see science as relevant to their worlds. This trait is not uncommon with teachers. It has been argued that competent teachers recognize and respond to the learning needs of their students within their classrooms. The ability to respond to the needs of students is not unique to these cases: Faith and David paid attention to the needs of their students within the classroom as many dedicated teachers do. However, they went further and responded to a need that they saw beyond the classroom.

For Faith, she found her students believed science was reviewing textbooks, memorizing facts, and reciting those facts on tests. Her students associated science with boredom and rote learning, and she wanted students to see science as an active pursuit that emerged from curiosity. For David, he recognized that his students saw science as a passive pursuit of knowledge that was far removed from their own experiences in life. The students did not see how science benefitted their lives and could be used to solve real-world problems. For both Faith and David, the opportunities emerged from ongoing conversations with students: In order for students to appreciate science as being relevant and important, these two teachers needed to engage students with reformed-minded science teaching that broke from the prescribed curriculum. To increase relevancy, both Faith and David believed students needed more exploratory, active experiences with science. What made their interactions with their students and the recognition of a need go
beyond being a caring educator to being entrepreneurial? David and Faith created new opportunities for students to engage with science beyond the school and within the community and went beyond the expectations of their role as teacher.

The concept of opportunity recognition and creation is commonly listed as part of the entrepreneurial process (Busenitz & Arthurs 2007; Shane & Venkataraman, 2000). Busenitz and Arthurs (2007) extend the opportunity discovery process to include social interactions. Interacting with others within a given environment provides the necessary information to shape the opportunities. For entrepreneurial action, a person must recognize a need or desire and then create a product or service that adequately addresses that need. In the realm of education, the needs of students are often expressed and recognized. For teachers to create opportunities that adequately address the needs of students and the community and to extend their teaching beyond the confines of classroom and school is when entrepreneurial action becomes useful. David and Faith recognized the need, and they went to lengths beyond the standard expectations of teachers to build opportunities that address the needs.

The opportunities David and Faith identified also emerged from their awareness of the current learning environments as well as their own backgrounds in science. David and Faith relied on their past areas of expertise in order to create these opportunities. Faith had led outdoor summer camping programs and participated in a summer science camp offered through a university grant. Using her past experiences, Faith created a new camp opportunity for her students to lead and for younger students to participate. David, a former engineer, relied on his past experience as an engineer to lead students through the design, build, and test cycle of refining biodiesel fuel and building biodiesel systems.
Shane and Venkataraman (2000) point out that opportunity discovery for entrepreneurs includes a combination of having prior information that allows entrepreneurs to detect the opportunity exists and a value for the importance of the opportunity. Those who act entrepreneurially often have experience and background expertise around their idea. The fact that Faith and David have both experience and content expertise may be critical to the success of their initiatives. A teacher with no prior knowledge in science and no experience as an engineer might have a similar idea as David; however, developing the biodiesel initiative might be difficult without the past experience and content knowledge.

As with other entrepreneurs, David and Faith identified opportunities in which past experiences, personal interests, and the needs of people shaped the opportunities they created. To deliver a successful service, entrepreneurs must provide services that people want and seek out. In order for the learning opportunities Faith and David provided to be successful, the students needed to buy into the learning, seek it out, and participate. Based on the interactions that Faith and David had with their students, they were able to create opportunities that students desired and actively participated in after school.

Developing reform-minded science teaching and experiential learning beyond the established curriculum. Transitioning the recognition of an opportunity to the creation of an opportunity requires people go beyond the established structures and services currently offered. Faith and David saw students would benefit from encountering science beyond the context of school. Given the confines of the established 45- to 50-minute class time; the given curriculum; the standards, objectives, and learning outcomes measured by high-stake tests; and the grade/age separation of schooling, they believed that needed science opportunities could not be woven within the existing structure of schooling. In order to branch out and connect science with
community, they needed to move beyond the conventions of school. While there was evidence that both Faith and David brought some reform-minded science teaching strategies into their classrooms, the reform-minded science teaching differed from the opportunities they created outside of the school. In the classroom, the learning was less open ended, more fixed to specified objectives, and tied to specific learning outcomes aligned to the curriculum. In the opportunities outside of the classroom, the learning was more open-ended, exploratory. Faith’s camps aligned with science in practice rather than specified knowledge acquisition: forensics, nanotechnology, and engineering, for example. The scientific concepts and experiments then connected with science at work in those areas.

Faith and David created learning opportunities that focused on students physically exploring with science, and these opportunities differed from the learning that was happening within their classrooms. While the experiences Faith and David were also different from one another, there were components to the learning that were similar across both cases, aligned with prior research in experiential learning and reform-minded science teaching, and seemed to attract students to these voluntary science learning opportunities. Faith and David recognized the need for students to have experiential experiences with science. The learning that they created outside of their classrooms provides insight into those voluntary, experiential experiences with science.

Dewey (1938, 2007) recognized this dichotomy between the aims of the teaching of facts and rote memorization of knowledge and the inclusion of more experience-based models of learning:

Conservatives as well as radicals in education are profoundly discontented with the present educational situation taken as a whole. There is at least this much agreement among intelligent persons of both schools of educational thought. The
educational system must move one way or another, either backward to the intellectual and moral standards of a pre-scientific age or forward to ever greater utilization of scientific method in the development of the possibilities of growing, expanding experience. (p. 89)

It is important to note that Dewey’s use of the words “scientific method” is not to be equated to the step-by-step teaching of the scientific method in school. Given the rise of objectives, prescriptive curriculum, textbooks, and high-stake tests, one might argue schools have moved backward according to Dewey. Even with the direction schools have taken, there are educators who desire to provide students with experiences to engage in scientific exploration. The difficulties of bringing experiences into an environment more focused on attainment of knowledge than experiences might be too great, and the need to work beyond school to create these experiences increases. The teaching that David and Faith do within the classroom matches the knowledge expectations of the school; however, their teaching beyond the school more closely aligns with providing students more open science exploration experiences.

Comparing traditional classroom science to science taught in alternative spaces. The classrooms of Faith and David aligned with the established curriculum of the school and their science departments. They taught the science subjects, topics, and knowledge they were expected to teach and tied their teaching to the behavioral outcomes that aligned with the school’s curriculum. Their classrooms seemed to include more experiments for students and active learning strategies than other classrooms observed; however, the scientific knowledge and topics mirrored that of the science curriculum for their schools. In contrast, the learning opportunities that they created for students beyond school incorporated topics not currently
within the school’s curriculum and seemed to align more closely to reform-minded science teaching.

Faith’s science camps covered topics not included in the school’s curriculum such as forensics and nanotechnology. David focused on developing alternative energy, a topic not covered in depth at the high school level. Students actually engaged in the practice of and worked to create and use alternative energy, which went well beyond the scope of the science curriculum. When teaching from a prescriptive curriculum and textbooks, teachers use factual material that has been within the discipline for many years. With the learning created beyond the classroom, David and Faith had the freedom to incorporate current topics within the field of science. They did not need to wait for the science to be added to the curriculum but could incorporate the science immediately. The newness also allowed more openness for students to explore questions to find the answers; the teachers may have had some science background in the areas, but they encouraged the students to explore and find answers to the question. The answers were not in a book; they existed in the world beyond the classroom.

By looking closely at the differences between the opportunities Faith and David created within their classes and the opportunities they created when acting entrepreneurially to create science learning beyond school, we gain valuable insight into the differences and what seemed to attract students to engage in science outside of what is mandatory and expected through their schooling.
### Table 6.1

*Traditional Classroom Science Education Versus Alternative Space Science Education*

<table>
<thead>
<tr>
<th>Types of Activities</th>
<th>Traditional Classroom Science Education</th>
<th>Alternative Space Science Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content-Based Lectures</td>
<td>Teacher Created Labs</td>
<td>Theme-Based Experiences</td>
</tr>
<tr>
<td>Teacher Created Labs</td>
<td>Practice Problems</td>
<td>Problem-Solution Action</td>
</tr>
<tr>
<td>Practice Problems</td>
<td>Collaborative Learning</td>
<td>Experiments</td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>Individual Development</td>
<td>Active Exploration of Concepts or Problems</td>
</tr>
<tr>
<td>Individual Development</td>
<td></td>
<td>Team-Focused</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning Material</th>
<th>Past Knowledge</th>
<th>Science Advances (New Topics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook</td>
<td>Teacher Created Labs</td>
<td>Questions</td>
</tr>
<tr>
<td>Handouts</td>
<td>Practice Problems</td>
<td>Experiments</td>
</tr>
<tr>
<td>Structured Exercises/Problems</td>
<td>Labs or Projects</td>
<td>Open-Ended Projects</td>
</tr>
<tr>
<td>Teacher Selected</td>
<td>Teacher Created Labs</td>
<td>Research</td>
</tr>
<tr>
<td>Standard and Objective Driven</td>
<td>Teacher Created Labs</td>
<td>Student Selected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Issue or Problem Based</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aims</th>
<th>Acquire Factual Knowledge</th>
<th>Develop Appreciation/Affinity for Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply Knowledge</td>
<td>Teacher Created Labs</td>
<td>Solve Problems</td>
</tr>
<tr>
<td></td>
<td>Practice Problems</td>
<td>Develop New Products or Services</td>
</tr>
<tr>
<td></td>
<td>Collaborative Learning</td>
<td>Explore Concepts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Role of Student</th>
<th>Recipient</th>
<th>Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partner</td>
<td>Teacher</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Role of Teacher</th>
<th>Designer</th>
<th>Co-Creator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manager</td>
<td>Guide</td>
</tr>
<tr>
<td></td>
<td>Focus on Knowledge Achievement</td>
<td>Focus on Inquiry and Action</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Role of Experiences</th>
<th>Supplemental Knowledge Application</th>
<th>Central to Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Knowledge Application</td>
<td>Co-Creation of New Knowledge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structures</th>
<th>Established by School 50-minute classes</th>
<th>Established by Opportunity Flexible</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Assessments</th>
<th>Test Results</th>
<th>Student Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Labs</td>
<td>Student Participation</td>
</tr>
<tr>
<td></td>
<td>Homework</td>
<td>Project Results</td>
</tr>
</tbody>
</table>

When building spaces for learning that extend outside of school, success is dependent upon young people attending. Without student interest and attendance, the space is empty, learning is not possible, and a learning environment is not created. Based on the cases of this study as well as the research conducted by Heath and Soep (1998), the inclusion of experiential learning and reform-minded science teaching seemed to be attractive to students and created interest and demand for the educational opportunities in these alternative spaces.
Using open exploration and problem solving. In the alternative spaces that David and Faith created, the main goal of the learning opportunities was to give students physical experiences with science and scientific concepts. They did not enforce curriculum mandates or recite behavioral objectives. David’s biodiesel initiative started with the question, What if we built a biodiesel system? Faith’s summer camps started with general science topics: nanotechnology, forensics, engineering. The learning that emerged from David’s question and Faith’s general science topics was driven by the students’ contributions and exploration of the topic and questions.

Faith and David both gave students challenges to pursue. David challenged students to build a biodiesel system or to beautify the school. Faith challenged students to create science learning experiences for younger-aged children. They both brought students past where they currently were with using science and opened up new spaces to learn science. Roberts (2005) speaking of experiential education, says,

*For if we take seriously the notion that experience in virtually all of its guises involves at least a potential learning process produced by an encounter with something new, an obstacle or challenge that moves the subject beyond where it began, then the necessity of an outside to the interiority of the subject is hard to deny.* (p. 403)

The end goal for Faith and David wasn’t knowledge in and of itself. Rather, they focused on the process of working toward something that was larger and more tied to the community needs. The path for getting to the end was not fixed, but it was determined by the students’ involvement and leadership.


*Providing new roles and responsibilities through cross-age learning and mentoring.* In the biodiesel and beautification projects, David was the only adult leader. Given the complexity of the project and scale, the students assumed responsibilities for the projects. Faith intentionally brought on high school students to be the leaders of the learning, and she and another teacher served as the directors. They served over 100 students during the summer, so the responsibility for their camps was shared with the high school students.

Heath and Soep (1998) used the term *distributed responsibility* in their research on effective learning organizations for youth. Given the nature of the learning and the limited adult and system oversight, students naturally begin to assume some leadership roles. Both Faith and David expected part of the student leadership to include students mentoring and teaching others. The inclusion of cross-age learning and modeling connected with Vygotsky (1978) and his theory of proximal development. The importance of learners collaborating with one another, Vygotsky argues, is that what they are able to do in collaboration today will in turn be something they can do independently tomorrow (p. 211). The assuming of leadership roles as well as the mentoring of others cut across the experiential learning opportunities that Faith and David had created.

*Allowing for risk and failure.* In the classroom, the greatest risks for students are the possibility of giving a wrong answer in a group setting or on a test and performing poorly on tests and quizzes. As a collective group, there are few, if any, risks for the entire class. Faith’s science camps and the Science Road Shows were presented to large groups of elementary-age students. The success or failure of these learning events was largely dependent upon the experience and teaching the high school leaders provided. In providing the learning
opportunities for younger students, the high school leaders were assuming the risk as well as the potential for failure.

David’s students presented their biodiesel, tested the biodiesel, and applied for grants and contests. The overall achievement with each of these was shared among the collective group. There was a chance for success and failure.

Heath and Soep (1998) explained that the arts-based youth learning organizations they studied provided for the range, degree, and frequency of risks to be different from other youth learning organizations. Students were able to use their imaginations to try old tasks using new methods. Faith and David selected science topics that also allowed students to take risks. Faith let students pick the experiments to be used during the Science Road Shows and science camps that the students felt would be most effective. David encouraged students to think creatively about how to expand the biodiesel initiatives. There also was a level of performance within both cases. The high school students in both cases were asked to stand up and lead presentations either in small-group or large-group settings.

*Using forms of rewards and recognition different from evaluative grades.* In schools, grades are still the pinnacle of rewards and recognition. Faith and David did not use any types of grades within their beyond-school learning opportunities. The rewards for being a part of the opportunities included expressions of gratitude, pizza parties, and t-shirts. Faith provided students with payment for their time, and David and his students received scholarship money for some of the work they were doing. Both Faith and David did use extrinsic rewards to recognize students; however, there was another level of reward demonstrated in the cases.
Pink (2009) focused on what intrinsic rewards drive performance. He includes the following three characteristics: autonomy, mastery, and purpose. Table 6.2 places the different opportunities created by Faith and David and illustrates how those opportunities align with Pink.

Table 6.2

*Pink's Autonomy, Mastery, and Purpose and Intrinsic Rewards of Biodiesel and Summer Camps*

<table>
<thead>
<tr>
<th>Pink’s Concept</th>
<th>Description</th>
<th>David’s Biodiesel</th>
<th>Faith’s Summer Science Camps and Road Shows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy</td>
<td>Self-directed</td>
<td>Voluntary student involvement</td>
<td>Voluntary student involvement</td>
</tr>
<tr>
<td>Mastery</td>
<td>Desire to improve</td>
<td>Design, build, test nature of the learning</td>
<td>Select experiments for students and adapt based on teaching</td>
</tr>
<tr>
<td>Purpose</td>
<td>Serve something larger than ourselves</td>
<td>Working toward providing electricity to a Haitian school and addressing environmental issues of traditional fuel sources</td>
<td>Providing science learning opportunities that offer summer programming to predominantly low-income students</td>
</tr>
</tbody>
</table>

David and Faith’s opportunities were 100% voluntary. The students engaged in the learning experiences chose to participate. Even with the physics courses at school, there was a compulsory nature to the classes. If students wanted to get into college, they felt compelled to enroll in the physics courses. Without the use of grades, the students gauged their successes and failures by how well their experiences were going. In both cases, the high school students were working toward goals that went beyond their own interests.

An intrinsic reward that seemed to drive the students and that is not included in the rewards offered by Pink is a shared commitment. The relationships that students built with one another and through the work they were doing seemed to be an integral part of their desire to work on science beyond school. Together, the students worked toward goals, solved problems, dedicated themselves to the same goals, and enjoyed one another’s company. The social dynamic of working after school was a reward that attracted not just David and Faith’s students but also others within the schools.
**Employing bricolage behaviors to fund and support science learning.** Drucker (1985, p. 34) explained that successful entrepreneurs often combine existing resources in new and more productive ways. This search and use of existing resources to underwrite new opportunities has often been labeled as “bricolage behaviors.” Baker and Nelson (2005) used prior studies as well as their own fieldwork to define bricolage as “making do by applying combinations of the resources at hand to new problems or opportunities” (p. 333). In their research, Baker and Nelson noticed that those with bricolage behaviors did not accept the limitations of their often resource-lean environments but rather seemed to have a greater awareness of the available, but potentially overlooked, resources. Within resource-lean contexts and schools, it is easy to spot deficiencies and limitations: lack of proper funding, inadequate equipment/supplies, poor test scores, and more. Faith and David existed within contexts considered to be resource lean; however, they approached these contexts with an eye for identifying areas of support. They often relied on existing resources and physical supplies, but they also identified community resources that were available but underused when it came to creating educational opportunity. They found physical spaces for learning to occur, and these spaces were free of charge. For Faith, she tapped into existing summer programming that provided the organizational supports necessary for her camps to operate on an annual basis. David partnered closely with university sponsors to acquire the necessary physical resources but also to supplement the background knowledge and expertise needed for transitioning the project of creating alternative fuel for local use to a humanitarian effort of making this fuel and a biodiesel system useful to a village in Haiti.

The resources that Faith and David identified varied in type, but there were consistent resources across both cases. These included physical resources, people resources, and financial
resources. There was an interwoven nature to the acquisition of resources; the acquisition of one resource may have created the pathway for acquiring more resources. So, for example, the financial resources may have created the opportunity to obtain the physical resources. As illustrated in Faith’s case, she secured the help of a significant donor for her science camp at the YMCA within Eastern. This connection with this donor led to the donor connecting Faith with the director of the Boys and Girls Club and the creation of the second science camp. In David’s case, the media attention he and his students received from winning the national science contest raised the attention of Engineers Without Borders and created the opportunity to build a biodiesel system and solar panels for their Haiti project. The following table provides a list of where the resources could come from:

Table 6.3

*Resources That Support Entrepreneurial Teaching*

<table>
<thead>
<tr>
<th>Physical Resources</th>
<th>People Resources</th>
<th>Financial Resources</th>
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</thead>
<tbody>
<tr>
<td>Place/Space</td>
<td>University Professors</td>
<td>Corporations</td>
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<tr>
<td>Equipment</td>
<td>Graduate Students</td>
<td>Chambers of Commerce</td>
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<td>Individual Donors</td>
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<td>Foundations</td>
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<td>Contests</td>
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<td>Media</td>
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<td></td>
<td>Community Center Leaders</td>
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<td></td>
<td>Nonprofit and Government</td>
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<td></td>
<td>Organizations</td>
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</tbody>
</table>

The cases of Faith and David illustrate the different resources that are available within low-income settings and that can be used to create new learning opportunities.

**Animating students to lead and in turn animate others.** In the realm of education, teachers, scholars, and politicians have put forth a breadth of ideas, theories, and strategies deemed to improve education; however, the transition from idea to action seems elusive. Faith and David recognized an opportunity to enhance student learning, sought out ways to move
beyond the school, and reached out to others to identify resources, but in order for their idea to take shape and establish student interest, they needed to build the interest of their students and others and get them actively involved in creating and sustaining the educational endeavors. Bresler (2009) describes this concept as “animation” in her work on intellectual entrepreneurs. She describes animation as “working with others to inspire, negotiate, and lead in making things happen. Animators create the persuasive conditions that help members of a field or domain to accept their work” (p. 19). Faith and David recruited their high school students not just to participate in the learning but to share their learning with others through becoming mentors and leaders.

One of the most central ways that Faith and David animated their students was to include them in the decision making and problem solving within the opportunities. Faith asked the students to explore different science experiments and activities and select those strategies that they felt would be most interesting to the younger students. As the camp went on, Faith brought the high school leaders together and asked them to decide what was working well and what needed to be changed. They were an active part of the opportunity. Their level of involvement during the Science Road Show was inspiring to the fourth-grade teachers, the principal, and the district administrator who attended. David used a similar approach in that he had students take on different roles and responsibilities. Again, the active level of engagement in high school students to build a biodiesel system and generate alternative fuel was inspiring to others within and beyond the community and helped them take an interest in and support the David’s initiative. David and Faith first animated their students, and in doing so, those students were able to animate others to support what they were doing.
The Nature of Support and Grit to Persevere in Creating New Learning Opportunities

As Faith and David pursued their experiential learning opportunities beyond the schools, they faced difficulties. In order to respond to those challenges, David and Faith used similar strategies for pushing forward, which included recognizing and using support and exercising grit to navigate the challenges that they faced. Schumpeter (1942, 2011) made reference to the aptitude of some to “act with confidence beyond the range of familiar beacons to overcome the resistance” (p. 132). This confident action even when faced with adversity matches with the concept of grit that has been studied by Duckworth et al. (2007). They define grit as “perseverance and passion for long-term goals. Grit entails working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress” (p. 1087-1088).

Faith and David continued to pursue creating opportunities for students to learn science beyond school over multiple years and in different contexts. In order to create the Science Road Show, Faith encountered several obstacles along the way, but she pressed on with the idea and found the necessary support by focusing on those people who had an interest in and supported the idea. David faced difficulty navigating the tumultuous financial climate of schools and the cycle of teacher reductions in force. Even though he entered into new schools, he continued to look for learning opportunities that appealed to students and continuously found grants and funds to underwrite these new learning initiatives. Both Faith and David acted with a level of grit to persevere when faced with obstacles. In addition, they constantly were seeking to find areas of support which included people, finances, and space in order for the learning opportunities to continue from year to year.
Insight Into Entrepreneurial Teaching

A review of the cases of Faith and David provides insight into the types of opportunities they created, the location of those opportunities, and the actions they took. This study used the lens of prior research from entrepreneurial literature and in doing so, developed a typology of entrepreneurial teachers as well as a model of the entrepreneurial action that Faith and David used to bring about new spaces for learning science.

Typology of entrepreneurial teachers. Zahra et al. (2009) recognized that entrepreneurial endeavors were different from one another in scale, location, and size of resources and created a typology of social entrepreneurship. This initial typology was useful; however, to recognize the unique nature of schooling, teaching, and learning focus, a new typology was warranted. When comparing and contrasting the educational opportunities that Faith and David created, there were similarities and differences that aligned with the Zahra et al. typology. To help provide perspective more closely aligned with the different entrepreneurial endeavors of David and Faith as well as the educational system, I adapted the work of Zahra et al. to create a typology of educational entrepreneurship. This typology serves as a way to classify entrepreneurial teachers, but it is not designed to be an evaluative measure of the quality of the entrepreneurial effort or teacher. Thus an infuser entrepreneur is not necessarily conceived to be better. The typology is also not meant to include fixed categories. For example, an entrepreneurial teacher may operate as a connector and keep an innovative learning opportunity at the local level. If through their efforts, the entrepreneurial teacher gains enough recognition from within the system and community, he or she may decide for the opportunity to grow and address larger learning needs and find the avenues to change the system. Through these efforts the entrepreneurial teacher might then be classified as an infuser.
It is important to note that it is possible that as a connector, an entrepreneurial teacher might be better serving the needs of a smaller group of students at the connector level than an entrepreneurial teacher operating at the infuser level who is making a larger scale, system level change. Thus, the classification of entrepreneurial does not equate to being a better, more successful entrepreneurial teacher.

Table 6.4

Typology of Entrepreneurial Teachers

<table>
<thead>
<tr>
<th></th>
<th>Connector (Local)</th>
<th>Creator (Community)</th>
<th>Infuser (System)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do entrepreneurial teachers do?</td>
<td>Address local unmet learning needs, possess the expertise, and obtain local resources to meet the needs.</td>
<td>Build and operate alternative spaces for learning opportunities, identify avenues of expertise, and obtain resources from within and beyond the community.</td>
<td>Enhance the current learning system through creating alternative spaces for learning within the system.</td>
</tr>
<tr>
<td>Scale, scope, timing</td>
<td>Learning opportunity is small given its attention to a local issue and the opportunities may be episodic.</td>
<td>Learning opportunity is designed around local, national, or international issues. Students have a longer-term of engagement in the learning opportunities.</td>
<td>Learning opportunity is a large-scale effort and is designed to enhance the school, district, or community educational system. The system is changed and the learning becomes long-term and ongoing.</td>
</tr>
<tr>
<td>Growth</td>
<td>Opportunity recognized by participants, supporters, and students. Given the local focus, local resources, and reliance on individual teacher, opportunity may remain at the local level.</td>
<td>Given broader recognition, the opportunity has potential for growth, if there is a system in place that provides the supports to institutionalize and broaden the learning.</td>
<td>Perceived as potentially disruptive by existing educational structures, which may threaten its viability within the system. Successful at growth if the program addresses a large gap in educational services and gains support of community and district leadership.</td>
</tr>
</tbody>
</table>

The cases of Faith and David illustrate the first two columns of this typology. The opportunity that Faith created was focused on a local unmet learning need, and she served as an example of a connector. The students, the opportunity, and her efforts remained within the
community of Eastern, the resources that she obtained were largely from that community, and
the recognition of the opportunity stayed within the community. The opportunities that David
created went beyond the community, and the resources he obtained and the recognition for the
work that he was doing with his students came not only from within the community but also
from a national level. The educational opportunity also focused on a larger social need:
alternative fuel sources. This broader social problem–based educational opportunity provided a
distinction between the opportunity that David created for students and the opportunity that Faith
created for her students. Zahra et al. offers a third level in their topology, Engineer, which I
adapted and included in the table. At this level, the educational entrepreneurial opportunity
becomes systemic. The learning opportunities are adopted by the system and can be sustained
even when the entrepreneurial educator is no longer present. For Faith and David, their
opportunities rely on their own efforts and abilities in order for them to be sustained. Neither
Faith nor David created an educational learning opportunities that altered the existing system of
education at the school or district level. Although these two cases do not provide evidence of
this level of entrepreneurial educator, this does not mean that this level of educational
entrepreneurial effort is not possible for teachers.

One example of an entrepreneurial teacher operating at the infuser level comes from
Ashoka, an organization created by Bill Drayton, a former management consultant. Through the
development of Ashoka: Innovators for the Public, Drayton searched the world looking for
individuals who were trying to bring about social change. Drayton’s goal was to “spot social
entrepreneurs when they were relatively unknown and predict the ones most likely to achieve
major impacts” (Bornstein, 2007, p.16). The first fellow to be admitted to Ashoka was Gloria de
Souza, an elementary school teacher in Dubai. De Souza was concerned by the rote learning of
students in the elementary school; the students were memorizing and repeating facts and skills rather than the exploration of the world around them. She took her students outside to learn, and this as Drayton pointed out, was not necessarily novel; however, it was the way she applied this concept within her context. She faced the difficulty of convincing other teachers and administrators of the value of an exploratory science curriculum. Once she was recognized and named as a fellow with Ashoka, de Souza was given financial support as well as time away from her classroom to devote to growing her learning initiative. She was able to use this time to grow this learning opportunity within India and the schools. She got results: “Within three years, almost a million students were learning with her methods” (Bornstein, 2007, p. 20). Research that focuses on educators operating currently and working to significantly enhance the current educational systems and within different contexts might provide more insight into the process and behaviors of entrepreneurial educators operating at the Engineer level of the typology.

**Entrepreneurial action in creating third spaces for learning.** The cases of Faith and David serve as examples of teachers acting entrepreneurially to provide new learning opportunities for students in resource-lean contexts. To illustrate, I developed a visual representation of Faith and David’s entrepreneurial actions that allowed them to move between school and community and to create new learning spaces through for students. Their ability to identify an opportunity, generate support, and exercise grit were central in their creation of learning within and for the community. The role of experiential learning was central to the spaces they created and may be central to student participation in these spaces.
Figure 6.3 The entrepreneurial actions Faith and David used to move learning beyond the school and into the community creating third spaces for science learning.

Implications

As the study unfolded, the development of third spaces for experiential education became an important issue and one with implications for teachers, schools, and communities. Within these new spaces for learning, the role of experiential education was central. My hope was that this study would contribute to the existing entrepreneurship literature and speak to entrepreneurial teachers. While the study provides implications for teachers who desire to create new learning opportunities for their students, it also illustrates some of the challenges and difficulties teachers face.

Creating third spaces for reform-minded, experiential education. Teachers often lament there is not enough time for learners to gain the necessary skills, knowledge, and experiences during the duration of a course. When the structures are established for the
teacher—time, topics, location, objectives, and assessments—the ability to provide experiences where learners and teachers can engage in dialogue about the discipline being studied, explore new topics within the discipline, and co-create knowledge based on shared interests seems to be an impossibility. Teachers such as Madhu Viswanathan, Faith, and David went beyond the experiences available inside the confines of the classroom to create new spaces for learning. These spaces are what Bhaba might call third spaces where cultural exchange without the established hierarchy can take place. Educators might find these third spaces as useful options for providing students experiences that they feel are lacking within the established classes.

David and Faith are not necessarily pioneers, for there are other examples of teachers who create these in-between spaces. Out-of-school science enrichment that encourage students to engage in scientific inquiries have shown to be important additions to traditional school science and especially for students in poorly funded schools (Hofstein & Rosenfeld, 1996, Luehmann, 2009). While this quotation ties specifically to science, various disciplines including the arts, as shown by the work of Heath, are developing beyond school learning that provide students with educational opportunities that build student engagement, appreciation, and development. Additional research in these third spaces where learning goes beyond the school and connects academic learning with the community is warranted.

**The role of experiential education in beyond-school learning.** The presence of experiential, reform-minded science learning in both cases seemed to be what attracted students to participate in science learning beyond the classroom. David and Faith incorporated experiences that were compelling to the students but also deemed worthy endeavors by those in the community and beyond who donated time, money, and resources. The use of experiential learning as something that draws in people is not new and has been used in camping programs,
outdoor education, museums, and zoos. The interesting aspect of David and Faith’s cases is how the experiential learning grew from the relationships with students, addressed a local interest, and matched with the community resources.

In a rush to spread well-received educational ideas into the marketplace, one might decide to take the opportunities that Faith and David created and duplicate them. When a district administrator came and saw Faith’s Science Road Show, he immediately wanted to see similar shows spread to all of the elementary schools. Roberts (2012) used the work of Ritzer and the term *McDonaldization* to describe how the desire to increase efficiency, calculability, predictability, and control has impacted organizations including education. With the McDonaldization of experiential education occurs, the quality of the overall experience declines. The learning is no longer focused on the individuals nor tied to the context of their lives, and this standardizing of experiential learning is detrimental. Faith and David created experiential learning for students that tied very closely to their contexts and communities. While experiential learning may offer some effective, engaging opportunities for students, the ability to rapidly expand the experiential learning is problematic. Effective experiential learning is co-created with students, developed within a specific community, based on the available community resources, and centered on a local need. When experiential learning becomes scripted, organized, disconnected from the individual communities, and spread to other areas through polished programming, the learning becomes less experiential and more instrumental and offers nothing new than the current educational experiences offered during the school day. The cases of David and Faith raise the importance of developing student- and community-driven experiential learning opportunities that run counter to the prepackaged educational opportunities and programs that are commonplace in many schools.
**Entrepreneurial action in developing new learning.** Many teachers have ideas for what type of learning experiences would help student grow and develop. The challenge for some is gaining the support and persevering through the difficulties to create the space. David and Faith provide support that entrepreneurial action can lead to new learning spaces. There is some research that has focused on entrepreneurial teachers; however, there is a need for more research that focuses on teachers working across the three different levels of the typology: bricoleur, constructionist, and engineer.

There is an opportunity for preservice teachers to become familiar with the strategies associated with entrepreneurial teaching so that they go into the teaching profession with an awareness of identifying opportunities, finding support, and exercising grit in order to create new learning spaces for students. Sharing the research associated with entrepreneurial teachers can also provide inspiration and support for teachers who are hoping to create new learning experiences for their students.

**Consequences and difficulties of entrepreneurial action within schools.** Teachers using entrepreneurial approaches may face resistance and ramifications within the culture of schooling. Both Faith and David made significant investments of time that went beyond their teaching contracts, and they both faced resistance when trying to operate their ideas when closely aligned with schools.

David built new learning opportunities but then had to walk away from them due to reductions in force. At Townsend, David faced conflicts with administrators who wanted to control grant funds that were to be completely under his discretion. The institutional environment of schools presents challenges for facilitating innovative projects and change (Payne, 2008). Although David had been recognized and rewarded for the projects, even being
named a teacher of the year, he had not served long enough to earn tenure at each of the three schools. Given the tough economic climates of the high-poverty, urban schools and their need to reduce teaching force, David was not able to secure a teaching home. The awards, recognition, and over $130,000 that he brought into science education for these projects and the schools were not factors in his ability to keep his teaching job.

Teachers who choose to act entrepreneurially will not necessarily find the happy ending that makes for great education-inspired movies and books, and it is important to note that failure will be part of the pathway of acting entrepreneurially. Even with these areas of resistance, these two cases do provide evidence that teachers acting entrepreneurially can navigate new pathways to create innovative learning experiences for their students.

The institutional structures of schools may not necessarily encourage or support teachers’ entrepreneurial endeavors; however, they do not restrict the ability of teachers to act upon the needs of their students to create opportunities that they deem as necessary. Schools and administrators may want to begin to pay attention to those teachers who are creating valuable learning opportunities for students beyond the school and behave as supportive actors in the same way as the community supporters did in the cases of Faith and David.
References


*Grantmakers in the Arts, 9*(1), 9–16.


Appendix A: EnLiST Grant Description

The two central cases emerged from the larger context of a grant through UIUC titled Entrepreneurial Leadership in Science Teaching and Learning (EnLiST). Because of the close link between the cases and the grant, a brief overview of the grant is provided for context purposes.

The grant, funded through the National Science Foundation, is a partnership between University of Illinois and school districts throughout the state of Illinois. The EnLiST grant is a five-year project that began in the summer of 2009, and this research study began in the fall of 2009. Using the initial cohort of EnLiST schools and teachers, the grant partnered with schools and/or districts that were struggling to meet Adequate Yearly Progress (AYP) as outlined by the state and the No Child Left Behind Act. The grant’s mission at the time of the initial study is described here:

EnLiST aims to build the capacity of a new generation of science teacher leaders who, armed with cutting edge content knowledge, a strong pedagogical repertoire, and entrepreneurial spirit and mindset, can effectively contribute to the transformation of science teaching and learning in their classrooms, schools, and districts. (EnLiST Brochure, 2010)

Through the EnLiST program, “EnLiST participants receive support for engagement in leadership roles at the classroom, school and district levels in implementing innovative instructional opportunities that are thought to increase student learning. As a teacher leader, participants will also be serving as a model of innovation for colleagues” (https://www.enlist.illinois.edu/about.php). A key component to the grant is found within the title of EnLiST, and this is the concept of entrepreneurial leadership.

The first cohort of teachers came to UIUC campus during the summer of 2009 and consisted of 15 high school science teachers from five different districts in Illinois. To identify the initial cohort of teachers, the project coordinator contacted school administrators in the five districts that had volunteered to participate in the grant. These administrators passed along the grant’s information and an online application to science teachers who they thought would be a good fit for the grant. Interested science teachers completed an online application. These applications were reviewed by the EnLiST project team, and the project coordinator then contacted those teachers who had applied inviting all of them to join the grant. A. Martin (personal communication, July 1, 2010), the EnLiST program coordinator at that time and now program director, explained this initial cohort of science teachers self selected to become part of this professional development program. Prior to joining the grant, these teachers knew the title of the grant: Entrepreneurial Leadership in STEM Teaching and Learning. For some, they may have been drawn to the program because of its title. The teachers who participated in the grant received incentives, so while their participation was voluntary, it was rewarded. Martin explained that EnLiST, when compared to other professional development programs, offered teachers several competitive, enticing incentives to help teachers commit to a three-year-long development program. These incentives included the following:

- Earn no less than $3,000 in stipends
- Receive high-quality professional development in science content, pedagogy, and leadership
• Opportunities to earn graduate credits
• Receive a Leadership Certificate from the University of Illinois.

Participants also received support for assuming leadership roles at the classroom, school and district levels. They were expected to pursue an innovative idea within their school and collaborate with peers, school staff, and district administration.
Appendix B: Entrepreneurial Spirit and Leadership in Education Interview Conversation Protocol

Interview protocol developed for the initial interviews and submitted as part of the Institutional Review Board approval process through the College of Education.

Interview Conversation Explanation
During these interviews, we will be asking teachers when, how, and what questions regarding their opportunities for development, innovation, and leadership. As teachers (or administrators), our respondents most likely have made changes that influenced the classroom, school, and the district. Our goal is to explore these experiences as they pertain to idea development, idea sharing, and implementation. By learning how teachers engage in transitioning an idea into reality, we will also explore the internal drive, external process, and the social environments they navigate.

These interviews will use a conversational interview technique rooted in grounded theory (Charmez, 2006). The following is an interview guide, and, as Charmez (2006) recommends, is designed to explore the topics while also fitting in with the teachers’ experience. The questions are open ended and are intended to allow the teachers to reflect on their experiences and elicit rich data. The interviewer will listen carefully to the language of the teachers and incorporate their language when asking follow up questions (Charmez, 2006, p. 35). Thus, the stories shared by the teachers will shape subsequent questions and interviews.

As Corbin and Strauss (2008) point out,

> Adhering rigidly to initial questions throughout a study hinders discovery because it limits the amount and type of data that can be gathered. It has been these authors’ experience that if a researcher enters the field with a structured questionnaire, persons will answer only that which is asked, and often without elaboration. Respondents might have other information to offer, but if the researcher doesn’t ask, then they are reluctant to volunteer, fearing that they might disturb the research process. Unstructured interviews, using general questions such as “Tell me what you think about” or “What happened when,” or “What was your experience with” give respondents more room to explain what is important to them. (p. 153)

As a result, the following general questions are focused on particular topics and will be followed up with additional questions that explore the teachers’ experience and thoughts related to innovation and leadership. The interview will be pragmatic in that it will explore the multiple perspectives and actions of teachers who are trying to solve problems within the context of their classrooms, schools, and districts (Charmez, 2006).

The entrepreneurial frameworks at the end of this protocol have been included in order to provide resources that will be reviewed in light of the interviews conducted.
Interview Logistics
Each interview is anticipated to last no more than one hour; however, the teachers will have time to share as much as they would like (or as little).

The face-to-face interviews will be conducted in the district at a time that is most convenient for each teacher. This could be before or after school, during free periods, or at another time selected by the teacher.

The consent form will be emailed to teachers prior to making the arrangements for the interviews. The teachers may return the signed consent via email, fax, or in person. At the beginning of each interview, the interviewer will ask for permission to record the interview, and if granted permission, will confirm permission during the audio recording.

Teachers will not be compensated for participating in the interview.

Interview Reminders
As the interviewer, be sure to do the following:
- Introduce yourself.
- Provide an overview of the purpose and length of the interview.
- Listen carefully to responses and ask probing questions to clarify responses.
- Pay careful attention to the time but do not rush responses.
- Allow for the participants to guide the interview through their responses, but be sure to focus on those issues related to entrepreneurial spirit and leadership.
- Give time for the participants to think through their answers.

Interview Outline
The interviewer will get each teacher’s permission to tape the interview, for example, “This interview will be taped. If you do not wish to be taped, I can take notes instead. At any time, you may ask me to turn off the tape. Do I have your permission to tape the interview?”

Demographics ***be sure to note this information***
- Name of interviewee
- Name of interviewer
- Date, time and place of interview
- Interviewee’s position and job roles

Follow-up questions will be based on the responses. The bulleted follow-up questions may be modified to align with the teacher’s experiences, and the interviewer will select those questions that help clarify responses. The interviewer will most likely not ask all of the following as time will be limited.

Topic 1: Motivation
As a professional, tell me about what you care about most. Potential follow-ups may include but are not limited to these:
- Why is this important to you?
How does this influence your work?
What motivates you when it comes to your teaching?

**Topic 2: Innovation/Change**

Tell me about a time when you made a change that influenced your class, your school, or your district. Potential follow-ups may include but are not limited to these:
- How did you go about making the change?
- What were you hoping to accomplish with this change? Tell me what you think were the outcomes.
- What was your experience moving through the change process?
- Were there people you had to influence or convince? How did you go about doing that?
- Tell me more about . . .
- In what ways was this experience rewarding (challenging, disappointing, and/or discouraging)?
- What peaked your interest with regard to this change?
- What resources were available to you or did you use?
- The change you described (refer to the example given) impacted the classroom, school, and/or district. Did you attempt to broaden the idea to the other classrooms, the school, the district? Tell me more about that experience.

How would you define innovation as it relates to education? Potential follow-ups may include but are not limited to these:
- How would you go about pursuing an innovation?
- How does one go about innovating within your school/district?
- What is your experience with innovation?

**Topic 3: Action**

When you think of leadership, what comes to mind? Potential follow-ups may include but are not limited to these:
- How would you describe yourself as a leader?
- How would others describe you as a leader?
- What has been your experience with being a leader?
- What made you decide to lead in this situation?
- Are there other teachers in the school or district who you would describe as leaders? How would you describe them as leaders?

This question is intended for those teachers who are members of Core 1. Through the EnLiST project, you are exploring new ways to approach science education. In order to pursue an innovative idea, how would you go about influencing your school or district to pursue this idea?
- What innovation are you most excited about pursuing?
- Who would you need to influence?
- How would you approach it?
- What would prevent you from pursuing?
- How would you navigate the challenges?

**Topic 4: Educational Environment**
Tell me about your school environment/climate as it relates to trying new approaches and implementing new ideas. Potential follow-ups may include but are not limited to these:

- How would you describe your school’s atmosphere?
- Describe the leadership within your school and/or district?
- What conditions in your school facilitate change (or hinder change)?
  - Describe the obstacles that you face when trying out a new idea.
  - Describe the resources that are available to you.

**Thank you**
The teachers will be thanked for participating in the interview and their dedication to EnLiST. The contact information of the researcher will be provided.

Entrepreneurial Background Research That Informed Creation of Interview Protocol

**Opportunity and Entrepreneurship Defined**

**Defined by Sarasvathy, Dew, Velamuri, and Vankataraman**
1. New idea(s) or invention(s) that may or may not lead to the achievement of one or more economic ends that become possible through those ideas or inventions;
2. Beliefs about things favorable to the achievement of possible valuable ends; and
3. Actions that generate and implement those ends through specific (imagined) new economic artifacts (the artifacts may be goods such as products and services, and/or entities such as firms and markets, and/or institutions such as standards and norms).

**Frederick Hess**
“With due credit to Peter Drucker, author of the seminal Innovation and Entrepreneurship, it may be most useful to think of educational entrepreneurship as a process of purposeful innovation directed toward improving educational productivity, efficiency, and quality.” (p. 2)

**Different Frameworks for Entrepreneurship**

**EnLiST Project Description**
- Have a strong sense of self-efficacy.
- Use effectuation and causation when making change decisions.
- Act as leaders in initiating, championing, and seeking innovation resources.
- Seek and share information and create resource materials with colleagues.
- Strengthen and expand social networks.
- Seek outside resources.

**Six-Category Structure of the MP5 Model by Price and Vojak**
- Motivation
- Personality
- Perspective
- Preparation
- Process
- Politics
Price and Novak note, “. . . these categories are not distinct; they tend to overlap and be intertwined with many of the other categories.”

**University Faculty as Entrepreneurs by Bresler, 2009**
- Vision and creativity in exploring, identifying, and creating opportunities
- A process of experiential learning including craft, and learning from failures
- Team leading and *animation* in working to render a vision into an entity that interacts with others’ experiences

**Six Qualities of Successful Social Entrepreneurs from David Bornstein**
- Willingness to Self-Correct
- Willingness to Share Credit
- Willingness to Break Free of Established Structures
- Willingness to Cross Disciplinary Boundaries
- Willingness to Work Quietly
- Strong Ethical Impetus

**Entrepreneurial Trends from Gaglio and Winter**

*Trends*
- Trend 1: Cognitive Psychology (Mental Models)
- Trend 2: Ontological Nature of Entrepreneurial Opportunities
- Trend 3: Re-Emphasis of Social Dimensions
- Trend 4: Widening Schism in Definitions of Entrepreneurial Opportunities

*Key Findings*
- People Scan Their Environments
- Knowledge of Subject
- Awareness of Mental Models
- Social Environment Matters
- Opportunity Type
- Schism of Definition
Table B.1

**Characteristics of Different Types of Entrepreneurs from Elfving (2008) (Carsurd et al., 2009)**

<table>
<thead>
<tr>
<th></th>
<th>Extrinsic entrepreneurs</th>
<th>Extrinsic &amp; intrinsic entrepreneurs</th>
<th>Intrinsic entrepreneurs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td>• Extrinsic motivation.</td>
<td>• A mix of intrinsic and extrinsic motivation.</td>
<td>• Intrinsic motivation.</td>
</tr>
<tr>
<td></td>
<td>• Centered around a specific entrepreneurial activity.</td>
<td>• Centered around the enterprise.</td>
<td>• Centered around the entrepreneur.</td>
</tr>
<tr>
<td></td>
<td>• Creativity and result as motivator.</td>
<td>• Independence as motivator.</td>
<td>• Networking and influencing as a motivator.</td>
</tr>
<tr>
<td><strong>Cognition</strong></td>
<td>• High self-efficacy regarding performing the business activity.</td>
<td>• High self-efficacy regarding the company and its abilities.</td>
<td>• High self-efficacy regarding being an entrepreneur.</td>
</tr>
<tr>
<td></td>
<td>• Unfocused visionary thinking.</td>
<td>• Focused and analytical thinking.</td>
<td>• Unfocused but innovational thinking.</td>
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<tr>
<td></td>
<td>• Opportunity recognizers.</td>
<td>• Opportunity discoverers.</td>
<td>• Opportunity creators.</td>
</tr>
<tr>
<td></td>
<td>• Do not know how to search information.</td>
<td>• Information users.</td>
<td>• No time for information search.</td>
</tr>
<tr>
<td></td>
<td>• Intuition influenced decision making.</td>
<td>• Analysis influenced decision making.</td>
<td>• Heuristical decision making.</td>
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<tr>
<td><strong>Goals</strong></td>
<td>• Entrepreneurship is a subordinate goal.</td>
<td>• Entrepreneurship is a focal goal.</td>
<td>• Entrepreneurship is a focal goal.</td>
</tr>
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<td></td>
<td>• Lower entrepreneurial goals mainly focused on surviving.</td>
<td>• Strategic and rational goals.</td>
<td>• High and somewhat abstract goals.</td>
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<tr>
<td></td>
<td>• Want to be profitable enough to survive.</td>
<td>• Profit focused.</td>
<td>• Being profitable is seen as an interesting challenge.</td>
</tr>
</tbody>
</table>

**Types of School Entrepreneurs from Joe Williams**

- **James Deans**
  - Achieve measurable results.
  - Have political support among stakeholders.
  - Commit to serving students.
  - Use creativity and breaks rules.
  - Do not necessarily achieve systemic change.
- **Bulls Managing the China Shop**
  - View rules as part of the problem.
  - Driven forward.
  - May cause controversy.
  - Get frustrated with slow rate of change.
- **Destiny Grabbers**
  - Are least recognized.
  - Use accountability and restrictions as opportunities.
- **Johnny Appleseeds**
  - Are rule followers.
  - Aligned with leaders at the top.
  - Bring about change within the existing system.
  - Pay attention to existing framework.
Key Entrepreneurial Concepts That Cross Over

Internal Awareness and Self-Efficacy:
• Motivation and Passion
• Goal
• Idea

External Awareness and Support:
• Structures/Systems/Rules
• Environment Scanning
• Opportunity Recognition and/or Creation
• Distributed Leadership

Social Awareness and Networks:
• Network
• Political
• Communication Avenues

Action Oriented:
• Identify Outside Resources
• Implement Change
• Garner Support

References


## Appendix C: Interviews and Observation Schedules

### Table C.1

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School</th>
<th>Observation</th>
<th>Interview</th>
<th>EnList Classroom</th>
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<tbody>
<tr>
<td>Arthur</td>
<td>Chicagoland A</td>
<td>1 hour informal observation in class.</td>
<td>1 hour onsite interview at Chicagoland A.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<tr>
<td>Bill</td>
<td>Midstate A</td>
<td>N/A</td>
<td>1 hour onsite interview at Mid-State A.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<tr>
<td>David</td>
<td>Townsend</td>
<td>3 hour observation in class.</td>
<td>• 1 hour onsite interview at Chicagoland B.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<td></td>
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<td></td>
<td>• 1 hour interview during Entrepreneurial Leadership course.</td>
<td>• 1 day workshop September 2010.</td>
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<tr>
<td>Magnet</td>
<td>Magnet</td>
<td>3 hour observation in class. After-school biodiesel club.</td>
<td>• 30 minute phone interview.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<td></td>
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<td>• 30 minute onsite interview at Chicago Magnet School.</td>
<td>• 1 day workshop September 2010.</td>
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<tr>
<td>Steve</td>
<td>Midstate B</td>
<td>N/A</td>
<td>1 hour offsite interview.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<tr>
<td>Evan</td>
<td>Rural School</td>
<td>N/A</td>
<td>1 hour offsite interview.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<tr>
<td>Faith</td>
<td>Eastern</td>
<td>• Two full days in classroom observations at Eastern High School.</td>
<td>2, 1-hour onsite interviews at Eastern High School.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<td></td>
<td></td>
<td>• Science Road Show event at an Eastern Elementary School.</td>
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<td>• 1 day workshop September 2010.</td>
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<tr>
<td>Gina</td>
<td>Midstate B</td>
<td>N/A</td>
<td>1 hour onsite interview at Mid-State B.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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<tr>
<td>Heather</td>
<td>Chicagoland B</td>
<td>N/A</td>
<td>1 hour interview during the summer Entrepreneurial Leadership course.</td>
<td>• 1 week Entrepreneurial Leadership course in Summer 2010.</td>
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Appendix D: Overview of Participant Schools

Table D.1

Overview of Participant Schools 2009-2010

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School</th>
<th>District Demographics</th>
<th>District Low-Income Level</th>
<th>Composite AYP Met in Reading and Math</th>
<th>2009 High School Drop-Out Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthur</td>
<td>Chicagoland A</td>
<td>93% Black 5% Hispanic 1% White 1% Multiracial</td>
<td>63% Low Income</td>
<td>No</td>
<td>1.4%</td>
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<tr>
<td>Bill</td>
<td>Mid District</td>
<td>46% White 37% Black 10% Asian 7% Hispanic</td>
<td>47% Low Income</td>
<td>Yes</td>
<td>5.9%</td>
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<tr>
<td>David</td>
<td>Townsend</td>
<td>93% Black 5% Hispanic 1% White 1% Multiracial</td>
<td>63% Low Income</td>
<td>No</td>
<td>1.4%</td>
</tr>
<tr>
<td>David</td>
<td>Magnet</td>
<td>30% White 31% Black 20% Hispanic 19% Asian</td>
<td>42% Low Income</td>
<td>Yes</td>
<td>1.8%</td>
</tr>
<tr>
<td>Steve</td>
<td>Central District</td>
<td>44% White 34% Black 7% Hispanic 6% Asian 9% Multiracial</td>
<td>61% Low Income</td>
<td>No</td>
<td>.4%</td>
</tr>
<tr>
<td>Evan</td>
<td>Rural School</td>
<td>58% White 25% Black 8% Hispanic 8% Multiracial 1% Asian</td>
<td>53% Low Income</td>
<td>No</td>
<td>5.9%</td>
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<tr>
<td>Faith</td>
<td>Eastern</td>
<td>48% White 41% Black 7% Hispanic 1% Asian 3% Multiracial</td>
<td>70% Low Income</td>
<td>No</td>
<td>6.8%</td>
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<tr>
<td>Gina</td>
<td>Mid District</td>
<td>44% White 34% Black 7% Hispanic 6% Asian 9% Multiracial</td>
<td>61% Low Income</td>
<td>No</td>
<td>.4%</td>
</tr>
<tr>
<td>Heather</td>
<td>Chicagoland B</td>
<td>93% Black 5% Hispanic 1% White 1% Multiracial</td>
<td>63% Low Income</td>
<td>No</td>
<td>1.4%</td>
</tr>
</tbody>
</table>

Appendix E: Sample Contact Summary Sheet

**FAITH CONTACT SUMMARY SHEET**

<table>
<thead>
<tr>
<th>Date:</th>
<th>October 21-22</th>
<th>Researcher:</th>
<th>Jeanne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx Time:</td>
<td>11 hours</td>
<td>Participant</td>
<td>(if applicable):</td>
</tr>
<tr>
<td>Location:</td>
<td>Eastern</td>
<td>Genre:</td>
<td></td>
</tr>
<tr>
<td>Event:</td>
<td>Interview and Observation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description:** Provide a brief description of event, and people. Use 5–10 words to describe qualities of the experience.
Quiet, organized, predictable, interesting, and expanding

**How did the artist invite the audience to engage in the experience?**
Faith was happy to have me come to her class. She also introduced me to her different classes. Her classroom was very organized. The students were comfortable in the classroom, respected Faith, and did pay attention throughout the two days I was present. Faith talked with me after each class, asked me questions, and was interested in my presence within her classroom.

**What emotions were evoked for you by the performance?**
There was a comfortable feeling to spending the day in Faith’s room both days. She is an organized teacher who pays attention to her students. This sincere interest, organized lessons, and pacing of her classes was comfortable. Faith’s classroom is a place for safe exploration... there is no dramatic risk taking, but she does allow students to explore using the different experiments she has within the room.

**Were you aware of any thoughts, insights, new knowledge, or directions to explore triggered by the performance?**
Faith is a solid teacher. She is not extraordinary, but she does care deeply for her students. I witnessed this in the way that she worked with students who were absent, answered questions, paid attention to students’ understanding, and responding with kindness but firmness when there were discipline issues or students responding incorrectly. Faith has been teaching for 24 years, and her experience and longevity as a teacher may be partly attributed to her solid but not risky teaching style. Her teaching of science class within the high school does not necessarily match the more inquiry-based teaching that she does during the summer science camp.

**Specifically, did the performance provide what you could call educational opportunities? Anything you would consider as an expansion?**
Faith is a warm person. She wants students to have “fun” with science and this came through in her interviews. I wonder in what ways she feels limited in doing this in the classroom in comparison (or contrast) to that of her summer camp. The summer camp has been going for 10 years, and she changes the curriculum each year. The other teachers feel that they are co-directors of the camp and share the vast amount of work that goes into it each year. Neither of
those that I talked with would take this on . . . too much work for them. I am interested in this idea of work versus reward. Why are some compelled to take on the extra load?

**What did you take away from the experience?**
Faith is what many might envision when they think of a classroom teacher. She has the right “dispositions,” has a sense of order within her classroom, and does not challenge the system. She exists well within the system. Even though she fits the mold, she has gone beyond her classroom and has been doing the science camp. There is something more to Faith . . . she went further than most teachers. Also, her teaching during the science camp differs from that within the classroom.

**Did anything (content, interaction style, etc.) surprise you?**
I was not surprised by this experience. I was pleasantly interested in how the two male teachers that were newer to teaching admired what Faith has done, but also, realize that they would not want to take on the added responsibility. Why do people decide to do more??

**Please suggest codes that you could use for this field-observation**
- Making science fun (need to further define)
- Sharing leadership (with teachers and students)
- Providing avenues for exploration
- Relating science to what students already know
Appendix F: Sample Field Notes Based on Conversation During Field Observation

Notes Taken During Participant Discussion on September 11, 2010 EnLiST Workshop
Are you better today than you were yesterday? (Pink, 2009, p. 156)

David
I am a better listener with other teachers. I was pretty good with students, but I hadn’t done that well with other teachers. The EnLiST teacher I am working with was hesitant. I had to stop and hear what he wanted help with, and he wants to start small. Patience, keep contacting. Listening to teachers more and better. Good with kids . . . listen to his needs rather pushing something onto him.

Iris
I liked the communication and help. Student who is autistic, and his aid was being mean. Can I help with anything? She was frustrated. Let me see if I can help. Student was ready to help, and the aide wasn’t ready to give help. Iris stepped in and mediate and communicated how to move forward.

Ken
Innovation should not just impact you but other people as well. Expand myself outside more. I have gotten over involved . . . that’s my theme.

Lenny
More aware of relationships with kids. Working more with other science teachers inside the school. Opening my way of thinking. Rediscovery of myself which is pretty exciting for me. I started the year more positively. I let the kids know the goals on a deeper level, and a more heartfelt lesson. Realization of habits and routines and want to think through new things. This is timely for me.

Instructor
Magic moment, if we work with students who are ready to be different, grasp the moment in our lives and other people’s lives . . . how do you make those moments different? Focus on the quality difference.

Mark
Frustration for me. Going back to school is 400 and nothing has changed. I feel different, but nothing else is different. I feel the pressure to go back to the way things were. I felt like I collapsed a little bit. Expect them to be different. Same speakers, same depressing numbers, the same programs. It became more clear that school seems to be an unchanging place. I am going to be pushing uphill against.

Instructor 2
The day before classes started, I was in panic. The classes start on Monday, and I had a very important meeting in the morning. I was teaching Monday afternoon. I was in an important meeting on Tuesday, and then I taught after that. I was working in advance trying to get ready, but I still didn’t feel ready. Talking to friend, I have to tell myself, “It isn’t a matter of what I have ready, but it is who I am when I show up.” The day I started, I wrote it down, “Who am I going to be?” I had a magic moment. One class is an incoming doctoral students, they all want to prove themselves. All these newbies are ready. One student said to another, “I just e-mailed the notes to everyone in class.” This is so cool. They all came thinking this is who I am competing with. We have accomplished that we were going to be colleagues. One of the students said, “My background is that my prior program was competitive. This was my expectation. I put myself in a box. I want you to know this is hard for me, and I am not done with this habit yet.”
David
The listening thing has really stuck with me. I realized how bad I was at it. It’s hard for me. You just want to jump in. The first day is hard. I tried to do something a little different. I avoid the rules on the first day. It’s a get-to-know-you day and science demonstrations. The first day getting off on the right off works for me. I had a class last year that didn’t work very well. I thought about this year, and I tried to get off to a better start.

Otto
It’s a little chaotic in the Science department. Science department is under construction. Two of the labs being ripped part, and the only lab remaining is mine. The library and computer labs are partially eliminated. All the teachers are trying to figure out what’s going on. I’ve gotten involved in two different programs. Arthur Eisencraft (University of Missouri). A lot of the teachers, because of the craziness and not having their routines, aren’t being flexible. I am more flexible. I had to put myself out there and be a better listener and more flexible. I have taken another teacher to help. I have the only lab room, the water is shut off and the electricity. Teaching chemistry with not water and electricity. I have been able to work out a routine. One teacher was resistant to sharing. Sat down at lunchroom and talked about what resources there were. By getting them together, we were able to share. We are at a hard spot or chaos, and I was able to sit down and talk. Finding yourself in a spot and finding ways to work through the problems.

Nick
Good help. I use to grade the lab, hand it back, with grade. If they did poorly, they threw it in their folder. They think it is done deal and don’t listen when I review this in class. Obviously, I wasn’t helping. I gave a pre-assessment about math skills (not physics), do it on their own, tell me what you can do. Returned it, gave them the grade, and the expectation is to redo it. Now, they can work with me, work with a peer. Vast majority of students did take advantage of this. I am thinking more about the help that I am giving students. It requires more work. Make them work to redo it and resubmit. The challenge is the time, and you are offering the help that you need. After or before school . . . 7:30–5:00. The challenge with 125 students, I know this is better and they are learning more, but it does keep me very busy. Tutoring program for budget cuts. Looking to work with U of I students to provide tutoring 3 nights of week. Science, math, and English with one faculty member who supervises. These three nights until 6:30, you can work there. Sometimes, I’m torn between my daughter’s swim meet. Lauren works in outreach . . . will you have needs for tutors? Broaden it to get a commitment 8–10 every night. Commitments from U of I.

Instructor 2
Grant announcement under public engagement. Faculty or student (possible) up to 20,000 for public engagement. This would come under that rubric. Support projects in school or community.

Instructor
Engineering students who are looking for service hours. This is the entrepreneurial side of things. How do you tap into other resources? If all of our good ideas only create more work for us, then we will collapse. Let’s find those who believe in our ideas. A couple of phone calls and e-mails can tap into things that will free up your time.

Instructor 2? Did some come from Pedagogy . . . Nick . . . the seed came from my own mind and then crystallized this summer. The math department moved away from it. Aware of students who are playing the system…but, trying a modified approach. Gradual for me. The idea to HELP a student . . . letting them discover it.
Faith
I’m really trying to be a better listener. I can always be reminded to listen. A student has a speech problem, and the students are struggling with hearing and understanding him and so she is. She reached out to his mom. The leader thing, and I am co-chair . . . and the other half said he was done. I did ask another science teacher to be the co-chair with me. Within my classroom, help my students realize their leadership potential. Trying to get the students up and front of the class.

Instructor 2
Looking at personal life, kids, and peers is important.

Faith
Who is going to be teacher today? I look to see who jumps up there.

Gina
I don’t know if there is one thing. This year for me has been complete chaos. I completely changed my curriculum. Two science and three ag classes. On top of that, I do all of the FFA. It is an extreme amount of work. It is very chaotic. I can’t pinpoint one thing. I see things we have talked about. I don’t have a lot of time, so I have to listen very intently. I have to listen to my kids, and we want to build leaders in FFA. I have leaders that people don’t always see. I use push and pull when it is sharing the ideas. Being a new teacher, the students expected things to be the same. I had to use different push and pull techniques to get them on board. They are not all there yet. I am not sure I am better, but I am much more busy. I feel that I am really helping kids discover who they are and be proud of who they are and develop themselves into whatever it is that they want to be. This development is so worth all of the chaos.

Instructor 2
Finding resources to help those who are busy.

Gina
I found a lot of people who do help. Some of things take kids to compete. When I grew up, it was true competition. All the advisors are more than happy to help. I have sent countless e-mails. It is amazing how many people want to come in and help. It’s still organizing all the help. It drives me to help more too.

Pete
Lego cars . . . that is what stuck. I enjoyed it. Students are a lot more engaged if you have an activity like that is fun. I haven’t done the legos. David and Gina are going to bring me in. What makes students want to come to the classroom? The personality of the teacher . . . is the class any fun? In science, we have the opportunity to have fun and do things.

Faith
Students are so engaged. They want to be entertained. We have to be entertaining on some level. We have to figure out entertaining.

Gina
The kids see me in a different light. They talk to me about what happened in class. The students share their perspective. This isn’t fun, could we do that? I have the luxury to do that. Students want to be doing. Listening to them and their needs.

Group Presentation (Mark, Pete, Faith, Ken, and Otto)
Pete
Idea was students in high school learn about space, then the high school students are going to teach elementary students about the solar system. This would require a field trip. This requires field trips form. Two elementary teachers that we worked with, so one class will go to one and one to the other. We haven’t made much progress and are thinking about second semester. Sophomores teaching elementary school, I think 4th grade. Similar to what my former school was doing, it provides opportunity for students who might be interested in teaching. One is walking distance and the other is short distance. We haven’t figured out the ideas. We are letting the elementary teachers drive this for now. We are working together with David on this. Brought up the idea to go to the planetarium. Get the families involved by having an event at the night. Ken brought up free software Stellorium . . . you can change the year, see the sky as it was and how the space moves. Celestia, free in space and zoom through it. Faith asked, “Could there be U of I students who have telescopes?” Mark said this is a challenge because the night is important. Otto mentioned that he was able to check out telescopes. Ken said there is a solar cam online (soho). Is there something online that provides the telescope images online. Pete, see Saturn through hubble’s eyes.

Mark
Reaching out for their help . . . authentic means for expressing knowledge. Struggle of providing hands-on learning when it comes to astronomy. Students creating lesson plans. Have an audience for these lesson plans. How do we share this with science literacy in the grade schools? What does it mean to learn science? Spoke with Fouad, elementary ed dealing with misconceptions. I still hope this happens. The kindergarten side, we are increasing their engagements. Balancing the number students with the classroom. I still haven’t finalized the write up. Scale, movement, and relationships . . . size. Videos . . . camstudio. Walk through the solar system. Different viewpoints on the flip cams. Demonstrate academic benefit . . . I want them to show that they are influencing and helping others learn. Compile the clips to make a video that shows the differences. Giving up classtime is a concern, my hope is that it is valuable use of time. Various ideas were shared with Mark, and those ideas are being considered. Planning for a Spring semester activity.

Otto
Recycling program. Start small. Special education kids were doing it, approached principal, I don’t want to step on toes. Feasibility of it went down the tubes. Personnel issues with taking the time to take care of that. I back tracked and Anita and Fouad had talked to Otto about incorporating nano into Chemistry courses. The text has charts that include nano elements to it. I met the author of the textbook, and I asked to see if I incorporated the nano elements I learned about during the summer. I wrote a proposal for incorporating nano and in partnership with a community college. Thursday, the proposal, bring in more activities, get some grant money, incorporate the middle school. Talks about working with Lenny who does Physics. Might incorporate the robots. Using ideas from the summer class. Part of the proposal is written to see if a nano course into the school. This might work similar to pre-pharmacy program that Otto has worked with previously. Multiple things flying around. I need time to sit down developed. Failure is not an option. Usually if you talk to the right people, if it’s going to work, it’ll work. If not, let it sit for awhile. It’s not necessarily your fault. I roll with the punches.

Discussing that there was a new school board. I developed a career health fair. We involve medical professional in the community to come in and do the fair. The push from the public relations is to put effort and energy in other projects right now.

Students aren’t very passionate about it right now. Kids are more engaged in a SAVE program. Students Against Violence Everywhere.

Mark
Tried to start a environmental club. Surprised by the fact that it isn’t part of the basic district responsibility.

Faith
In Danville, there is a recycling company. We had them put bins outside the school.

**Changing gears *****Instructor Presents About Intrinsic Motivation*****

Instructor used the iFoundry example that he is working on to demonstrate tapping into students’ intrinsic motivation.

David
Reaching out to the different community partners. Mentoring another teacher to find resources outside of the school.

Nick and Iris
Something that changed . . . We are planning things out more. Where, time, day . . . trying to write the proposal. Getting a starting place is important (Instructor 2’s thought).

Lenny
We are in the same phase of detailing the project. We need to go back to the beginning . . . we really need to start to figure out which projects we are going to try, get resources, master it in our own project. Start at our level with what we can control the most.

Are there things that you will do that will capture the emotion (Instructor’s question)? Where’s the passion? How are you going to push/pull them at another level?
Lenny explained its pure science, it’s cutting edge science, new career paths, projects are cool . . . see a couple of cool science things. Instructor said, “You are thinking through the intellectual piece, but now think through emotional piece.”

Iris made a PowerPoint that includes the cool aspects of science . . . nanotechnology in its impact on cancer research. See the cool stuff and why they should learn science. Expose them to what is going on.

Instructor 2 talked about the importance of emotional goals. Why are you doing what you are doing?

Otto
We are developing it. Incorporation of getting people. Right environment to get something done. We did a revision to the project when we met with the middle school level. We have come to a realization of what we could do. With her interest, we could develop something with the middle school kids. She said she had a Science Club. Her eyes lit up when talking about the community. She had funds to help support the project. Her excitement might flow to the kids. If that happens, the middle schools kids will help make things happen.

Faith
Trying to determine which kids would go into the elementary. She is going to let her students have more say into which activities would be helpful in the school. She may decide to ask students who would be interested in going to school. Having students plan as a group. Appeal to the extrinsic motivation (get out of school). Instructor mentioned that it would be helpful for them to feel the motivation to do it. Instructor 2 reiterated that Instructor’s statement harkens back to Push and Pull. Pulling them in rather than pushing them in. The allure comes from the emotion.
Ken
I am trying to take AP calculus class. Flip the traditional model so that problem solving during class. Trying to balance grading with senior level problem solving. Instructor 2 brought up the Respectful Structured Space, so that they have the support that they need to innovate when it comes to calculus. Reason I’m teaching AP calculus because the parents pushed the former teacher out. This is a situation with pressure, but Ken feels that he can justify what he is doing. Students are in it for a reason; appeal to what they want to do in life. New to them . . . building something new rather than learning what is already known.

Mark, David, Gina, Pete
Emphasis on gradual change. Modeling come in, make a survey to see what parents know, determine literacy standard, get teachers to buy in how the students are going to look up to them. His students going over three times . . . the third time will incorporate the students’ interest rather than the elementary school’s teachers’ interests.

Mark
Originally how to be an expert, but rather than bring elementary pre-service teachers. Help students get to know what kindergarteners need to learn. Expose them to the concept that you are learning through teaching kindergarteners. Convince them that is okay.

Gina
When students see the value in what they are doing, that makes a difference. Students want to go into the community to help. By tapping into that motivation, they can bring motivation out in their peers. There are kids who are looking forward to an upcoming soil activity, and they talk to the other kids. She uses that excitement to help in the class and pass on the excitement to other students.

David
He’s noticed that students have an inherent interest in eco-projects. He has used this to help students explore . . . their idealism. Students believe that the world can be perfect. What can I tap into that they are really going to dig? If you tap into, it will take off like a wildfire.

Instructor 2 and Instructor shared the importance of
See It, Own It, Solve It, Do It

Importance of getting important buy in and seeing differing perspectives. Also, the importance of changing the perspective to match the reality. If a battle is over, then find a new way to come into the situation to alter the perspective. Drive page 158. Think about what would Instructor do in this situation, or think of someone you respect and what would they do given this situation. Going oblique . . . taking a view from the balcony. If you are in a negotiation, take an overhead, objective third party perspective. See things from a different vantage point.

Also, consult with people without knowing the answer. Involve the group to identify issues and collaborative thinking and listening. It may not be about solutions but more about how to make positive steps forward.
Appendix G: Sample Memo Based on Data

July 4, 2010 Memo: Teachers differentiate change from innovation.

In all of the interviews, teachers did distinguish between change and innovation. It wasn’t always a clear-cut distinction, but it was one that they worked through in the dialogue.

Curriculum changes aren’t necessarily seen as innovative, but several teachers provided curriculum work as the change that they have been involved with in their schools. Teachers described curriculum change as picking a new textbook or reworking what was already in place. For one teacher, it was merely a process of inserting the latest “buzz” words in education.

In describing the most recent change to the curriculum in which this teacher played an important role, he shared, “We were just told to look at our curriculum and there are more buzz words out there in education. They want what’s called essential questions; they used to be called – I don’t know – core knowledge, and you know learning objectives. They just keep changing the names, but it means the same thing to a teacher. I mean it’s what are you going to cover, and they’re having us right it down why it’s important we cover it.”

When teachers I spoke with were asked about the change they had been involved in their schools, their examples included these:
- Reworking/revamping curriculum
- Changing an approach in their classroom
- Committee work initiated from the top-down . . . directive to change

As a follow up teachers were asked about innovations. Teachers differentiated changes in education from innovations. When it came to defining innovation, they described these:
- Larger-scale initiatives that reached beyond their classroom
- Involved securing outside sources (grants)
- Interdisciplinary (boundary spanning)
- Creative
- Student-centered

The larger the innovative project; the more difficulty teachers shared that they have. Two teachers shared the difficulty of working with administrators when working on larger scale projects. Since I only have interviews of the teachers, I only have the perceptions.

All of the teachers included examples of how they have pursued an innovation in their eyes. Examples included these:
- A multidisciplinary program for high school students
- A biodiesel engine that turned into a large-scale partnership to supply power to a Haitian school
- A summer science camp that has been successful for eight years in two cities that the model is trying to be brought into the district
- Experiments and inquiry labs within the classroom
• An agriculture class that is being redeveloped and now cross listed as a science class

My Free Writing on All of This
Teachers see educational change differently than innovation. The change is seen as something procedural or necessary as part of the function of school. The change often doesn’t come from within the classroom . . . it is an external influence. When teachers describe innovation, it is more tied to students and the teachers’ own core passions. For example, the former engineer is the one who worked with students to build the biodiesel engine. The teacher who grew up on a farm and who believes strongly in the role of agriculture in science is who is bridging the agriculture class for science credit. Teachers, have personal identities that include backgrounds, beliefs, and cultures. This identity does appear to influence their teaching, but it also appears to influence the innovations they choose to pursue. When it comes to having the energy to see a new idea to fruition, the idea appears to be connecting to their own sense of who they are and what is important.

As a teacher has an idea that grows, the teacher faces difficulties (perceived is all that I have at this point). For one teacher, this included not being asked to return. Innovation does not necessarily equate to personal success in the role of teacher. Thus, innovation is not always positive . . . it can come with consequences.

Innovation does appear to have a price tag. The role of grants and securing additional funding for creative projects was prevalent in the interviews. Teachers relied on their own money, universities, local businesses, and grants to fund their ideas and secure resources. Time to do this was in addition to their normal workload.
Appendix H: Fat Data Session Notes

Koehler Formulating the Study . . . Still Work in Progress (AGEE)

What drives teachers to pursue entrepreneurial activities?
- What forces do they encounter when pursuing these activities?
- What sustains them in these pursuits?

Formulating a Question
What drives teachers to pursue entrepreneurial activities, and what forces do they encounter when following this drive?

Description of the Study
This explorative study focuses on a group of science teachers who are participating in a National Science Foundation grant about Entrepreneurial Leadership and Science Teaching and Learning and their drive to pursue educational change as well as the forces at work when it comes to educational change. Specifically, I examined these teachers’ experiences with school change.

What do I want to know in this study?
I want to know about teachers’ motivation to make a change. The scale of their effort does not diminish the importance of the change; however, it does speak to the drive of the teacher and the perceived or real forces at work. I want to know what drives these teachers to make changes? Are they internally motivated, externally motivated, a little of both. And then when driven to change, what do they encounter within their environments: support, resistance, constraints.

What’s going on here?
Teachers are participating in a rewarding grant and are being asked to facilitate change on the systemic level. Their ability to (forces) and their drive to (motivation) influence change are at work. Their success or failure to achieve will be tied to the success and failure of the grant.

What are the basic social processes?
A significant social process at work is that teachers exist within the social domain of public schools. There is a culture to schooling, and they are all part of this culture. There is a school atmosphere of testing, and the schools targeted by this grant are considered to be failing to meet adequate yearly progress. These teachers exist in schools that the state says need to change or run the risk of losing funding.

Another social process at work is that not only are these individuals teachers, but many are parents and spouses. Many of these teachers, who have family responsibilities, mention that their family obligations often take precedence over their commitments to the grant (and at times, teaching).

What are the basic social psychological processes?
Overall, the teachers don’t seem to be driven beyond their classrooms. There are two teachers who have provided examples of projects that they were driven to do that went beyond their classroom and school. I’m wondering if the perceived forces related to school change tend to
squelch the drive, or if the teachers drive is more tied to routine and order (status quo), thus meaning that people driven toward radical change are not attracted to the environment of schooling.

**What is the relevance of the study to a field or discipline?**
Teacher-driven change can be informed by better awareness of teacher drive for change and the related forces that a teacher works within. My hope is that this study speaks to teacher drive and environmental forces.

**What is the nature: exploratory, explanatory, descriptive, and emancipatory?**
I would say the study is exploratory.

**What is happening in a particular situation with a particular person or group?**
Today, we’re going to focus on Faith: Faith has a science camp each summer and this results in a community outreach project for 1-8 graders and includes high school student volunteers. This camp is done in partnership with the Boys and Girls Club and the YMCA. As a teacher, Faith operates well within the school system, reaches out to community members for help, and gains support of other teachers. The change isn’t too radical, but it has been successful in two different communities and has happened for over 10 years.

Reference:
Appendix I: Sample Interim Report

September 2010 Interim Report

*Teachers Within EnLiST*
All teachers interviewed are participating in a grant funded by the National Science Foundation. Their schools were selected because they have high low socio-economic status students and were struggling on the standardized state tests. All of the teachers were teaching science when the grant began.

*Issue for this Interim Report*
As Stake indicates, an issue connects to social, historical, political, and personal contexts. For this interim report, the focus is on what was the thrust for the change that these teachers described. What made them decide to make a change in their classroom, school, and in one case, community. By taking a closer look at what/where change begins, we may better understand how teacher-initiated change takes shape.

*Teachers and Change*
While I am not a fan of tables, I will use one in this report to help compare the teachers’ examples of change,

Table I.1

*Teacher Overview*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School</th>
<th>Change</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthur</td>
<td>Chicagoland A</td>
<td>Rewriting curriculum</td>
<td>Failing school so using outside source to structure curriculum rewrite.</td>
</tr>
<tr>
<td>Bill</td>
<td>Mid-State A</td>
<td>Classroom experiments and demos to increase student interest</td>
<td>EnLiST, other university camps.</td>
</tr>
<tr>
<td>Bill</td>
<td>Mid-State A</td>
<td>Curriculum restructure</td>
<td>Administration driven to address “essential questions.” Teacher called “buzz” words.</td>
</tr>
<tr>
<td>Bill</td>
<td>Mid-State A</td>
<td>The Academy (integrated curriculum for mid-level, at-risk students)</td>
<td>Unclear.</td>
</tr>
<tr>
<td>David</td>
<td>Townsend</td>
<td>Biodiesel Engine and Grant</td>
<td>Kids bored and not enough funds.</td>
</tr>
<tr>
<td>David</td>
<td>Townsend</td>
<td>Haiti Project</td>
<td>University reaches out based on biodiesel project.</td>
</tr>
<tr>
<td>Steve</td>
<td>Midstate B</td>
<td>Teaching the atom differently so that it is more relevant</td>
<td>Summer class at U of I. EnLiST. Other teachers.</td>
</tr>
<tr>
<td>----------------</td>
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<td>----------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Evan</td>
<td>Rural School</td>
<td>Use of discrepant events and inquiry-based teaching</td>
<td>EnLiST and own experience with misconceptions.</td>
</tr>
<tr>
<td>Evan</td>
<td>Rural School</td>
<td>Fire extinguisher training after school</td>
<td>Remember similar experience from college.</td>
</tr>
<tr>
<td>Evan</td>
<td>Rural School</td>
<td>Curriculum mapping</td>
<td>Administration.</td>
</tr>
<tr>
<td>Faith</td>
<td>Eastern</td>
<td>Continuous change of projects</td>
<td>Student feedback, personal engagement in projects, and student comprehension. Use of outside sources.</td>
</tr>
<tr>
<td>Faith</td>
<td>Eastern</td>
<td>Taking on POE course</td>
<td>Teacher retired.</td>
</tr>
<tr>
<td>Faith</td>
<td>Eastern</td>
<td>Community science camps</td>
<td>Took over a camp in another city that was going to go by the wayside. . . concerned about students saying science wasn’t fun.</td>
</tr>
<tr>
<td>Gina</td>
<td>Mid-State B</td>
<td>Change to science curriculum and courses</td>
<td>Original change started with textbook review scheduled by district and based on experience in classroom.</td>
</tr>
<tr>
<td>Gina</td>
<td>Mid-State B</td>
<td>Ag class being cross-listed with science</td>
<td>Ag teacher departing, personal credentials allowed her to step in, personal beliefs about the connection between agriculture and science drove her to pursue a cross-listed status.</td>
</tr>
</tbody>
</table>

**Observations on Change**

**Curriculum Change**
For the teachers who described changes to the curriculum, the change was *initiated by the district administration*. For one teacher, the label of being a “failing school” is what created the drive to revamp the curriculum. In another example, the teacher felt that the change to the curriculum was created by the need for the administration to be using the latest educational “buzz” words. In another instance, it was the scheduled review of the textbooks that brought about a change to the curriculum.
In the curriculum change examples, the immediate presence of the students was not as strong as when teachers described other changes. There was mention of programs such as Understanding by Design; however, the students’ needs, interests, and connection to classroom was not nearly as strong as when teachers described other changes. The curriculum change was tied more to testing/performance and school performance. Gina did describe curriculum change that addressed student levels.

The curriculum change examples did include examples of teachers collaborating with other teachers in the district to develop the curriculum. Thus, the change was not performed in isolation . . . it was done in partnership with other teachers who serve on committees.

Classroom Change
The teachers provided examples of how they change their science teaching. For many, this change is driven by the desire to increase student interest and understanding in science. Teachers found these ideas through different avenues. Several specifically mentioned the EnLiST courses as providing ideas for engaging students. The teachers located near the UIUC provided other summer courses they had taken as being the source for experiment and teaching ideas. The teacher who discussed continuous change provided a multitude of avenues for identifying new ideas. She talked about her graduate education, her engagement in summer courses, other teachers, and seeking out ideas on the Internet. She begins looking for new ideas based on student feedback, student understanding, or her own enjoyment/engagement with the project/experiment. Bill echoed the importance of his own engagement when doing experiments. If he gets “bored,” then he, too, will change the experiment.

For another teacher, seeing the excitement and engagement of students in a fellow teacher’s classroom was what made him decide to include a methane bubble experiment into his class and then into the curriculum. The motivation to make changes in the classroom appeared to be closely tied to what was important to these teachers. I will want to include this in a later report. The teachers’ were fairly united in their responses to what they care about most: student enjoyment, engagement, and understanding.

Change that Reaches Beyond Classroom and Includes Students
Three teachers described changes that connected closely with student engagement and went beyond the classroom. I did not include the curriculum in this category, as the presence of students was not visible. Here are the three change examples that went beyond the classroom but also included students:

• Fire Extinguisher Training after school
• BioDiesel Engine and Haiti Projects
• Summer Science Camps

The Fire Extinguisher Training was a single event that happened after school. This teacher remembered doing something similar in a college course, and he remembered that it had an impact on him. He then built a similar experience within the school. He reached out to the local fire department to help, and he was able to get the extinguishers donated. The event was a success, and the students wrote thank you notes to the fire department. He attempted to hand this over to a new teacher to the district, but the event has not continued.
The BioDiesel Engine project came about because the teacher noticed that the students were not interested in science and did not see a practical application. It also came about due to the district having limited funds to purchase equipment to conduct practical applications. The teacher secured a large grant to get the equipment. He also continued to supplement resources through other grants and support from area businesses. Students stayed after school to work on the project, the project gained notoriety, and then grew into a project for Haiti. The teacher was not invited back; however, the project was adopted by a private school and is continuing.

The summer science camps began when a teacher realized that a local science camp was going to be discontinued. She was driven to create a “fun” science experience for primary and middle school children who said “science is boring.” She took over the camp, and when she moved to her current school district, she started the camp in this community. She has enlisted the help of high school students and fellow teachers, and she holds two camps that serve 100 students. She has secured resources through local grants to which she submits her camp proposal each year.

The changes that reached beyond the classroom had some striking similarities:
- Driven by student engagement in science and practical applications.
- Need for outside sources to fund the projects.
- Had student involvement that went beyond the standard school day/calendar.

The science camp project has spanned several years, and it has been accepted by the community. The BioDiesel project did span a couple of years; however, the ongoing maintenance of project funds created a conflict with school administration. This project is no longer housed in the public school setting but has been adopted by a private school. The fire extinguisher project was much smaller, and it only happened once. When the idea was shifted into the hands of another teacher, it was discontinued. The involvement of other teachers, community members, and local businesses may be critical in keeping a project going. The Biodiesel and Fire Extinguisher examples did not include other teachers as being included in the implementation.

**So What?**
Teachers do engage in change on differing scales. Changing curriculum is driven more by school performance issues and the educational context. Changing a lesson is driven by the teacher’s desire to increase student engagement, interest, and understanding of science. The teachers do seek outside sources to improve science teaching, and they do have a certain amount of autonomy to try new things in the classroom. Change that reaches beyond the classroom requires outside resources, and if it is sustained, includes other teachers and community members.

I don’t know that anything within this interim reports informs what we already know about change when it comes to schools and classrooms. I do believe it demonstrates that teachers do try to cross the typical boundaries, and they do not match the stereotype of the lone classroom teacher.

If we come back to Stake’s issue concept, then there are elements that tie to the changes teachers shared in the interviews.
The teachers’ personal experiences did inform the changes they wished to make. One teacher who had an agricultural upbringing did play a role in her belief and desire to see a cross-listed agriculture/science course. A teacher who found his experience with his own misconceptions being shattered in relation to science, wished to provide those same experiences for his own students.

The political environment of education did influence the need for change. The fact that all of these schools have come under fire for their lack of performance on standardized tests was apparent in the need to redo the curriculum. The politics of schools was apparent in the teacher who secured the large grant funds. His self-initiated project eventually ran counter to the political system in place for the district. This conflict came with the result of not being invited back to teach. Those changes that did not challenge the politics of the school did not have the same level of conflict.

I have not considered the historical nature; however, the changing nature of science did present itself in a couple of interviews. Also, the thrust of testing and school report cards was also prevalent. The reports of American schools falling behind in science is a current that runs behind all of this, and it is most likely why the NSF is funding this project.

On a social level, the teacher who spoke most about her interactions with other teachers is the one who has had a long-lasting project. This interaction with others and inclusion of the community may be an important aspect of creating a long-lasting change. Those teachers who reached out to find local support for their ideas were successful. This is interesting, as it appears the social environment is receptive to teachers who want to provide new, different opportunities to students.