THE TEACHING OF SCIENCE TO REFUGEES IN GREECE:

A MULTI-SITE CASE STUDY OF VOLUNTEER EDUCATORS IN

NON-FORMAL EDUCATION SETTINGS

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ABSTRACT

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This qualitative multi-site case study examines the experiences of four volunteers serving as educators and their use of science kits in three separate non-formal refugee spaces located in Greece. They received professional development and materials to support their teaching of science. An adapted Teacher-Centered Systematic Reform (TCSR) framework was used to analyze the relationship between personal factors, teacher thinking, practice, and contextual factors. Data sources for this study were pre- and post-activity questionnaires, pre- and post-activity journaling, observations, and structured interviews. Each of the data sources was analyzed to develop an understanding of the volunteer educators' personal factors, teacher thinking, teacher practice, and contextual factors to identify emerging themes. Emerging themes provided evidence to better interpret the experiences and perceptions of volunteer educators who used science-kits in non-formal refugee educational settings. These themes were then compared between and across each case to find similarities and differences between volunteer

educators. This research contributes to both the field of science education and the preparation of volunteers in emergency education to teach science.

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E.S.G.

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INTRODUCTION

Rationale of the Study

According to the United Nations High Commissioner for Refugees (2016), many refugees face disrupted education, with as many as thirty-seven percent worldwide not attending formal primary schools. In Greece, seventy-five percent of refugee children do not attend school. Instead, many receive their education from volunteer educators in local community centers and informal education programs located within refugee camps (United Nations High Commissioner for Refugees, 2016). A concern is that many of the volunteer educators serving refugees do not have a background or training in how to teach or what to teach in refugee settings (Ficarra, 2017). Therefore, the lack of training leads to volunteers being unprepared to meet the needs of refugee learners academically, socially, and emotionally.

Children around the world who come from conflict-affected areas experience interruptions to their education and very often do not have opportunities to engage in meaningful and systematic formal instruction. Many of these children attend non-formal education programs located in refugee camps and community centers that provide them with significant venues to re-engage and continue with their education. For still many others, these non-formal programs give these children their very first experiences with learning. Lederman (2016) wrote of the role of science education in our current global society. He stated, “We must seek out and take advantage of every opportunity to improve society through science, no matter how difficult or insurmountable the task may seem" (p. 2). Science is an essential subject for refugee children to learn. According to Holbrook (2010), science education supports socio-scientific decision making and scientific problem-solving. Developing these two abilities, according to Shamos (1995), impacts true scientific literacy, which is defined by Shamos as an understanding of science by citizens globally so that they can participate in decision making on societal issues using scientific knowledge. Therefore, to promote scientific literacy for all children globally, we must work toward developing resources and materials to support the learning and teaching of science in non-formal refugee spaces.

The volunteer educators serving refugees in non-formal refugee spaces play a significant role for these students and their learning experiences. A study completed by Gillette and Halpern (2018) found that volunteer educators may have training as in-service teachers or can be untrained volunteers that have come to the refugee camps to lead activities and offer lessons. Also, the majority of the volunteers in the study were found to come from European countries or Australia. They volunteered to stay for a range of time from two-weeks to two-months. The finding from the study found that science education can be particularly challenging for volunteer educators to deliver in non-formal refugee settings. The participants reported a lack of background in teaching science and expressed little confidence to teach (Gillette & Halpern, 2018). As a result, the quality of science education suffers. Without exposure to quality science education and adequately prepared teachers, children will be less likely to develop a positive attitude towards science (Maltese & Tai, 2008; Rowe, 2003; Wayne & Youngs, 2003) and develop a science identity, which can hinder the development of important life skills. The backgrounds and experiences of these volunteers with science have an impact on their beliefs and self-efficacy. Such self-evaluation and sense of competency are essential for creating an environment where students can learn, and specifically learn science.

To date, there has been limited research on the teaching of science in non-formal refugee spaces. There have been two studies completed by Welzel and Breuer (2006) and Perrier and Nsengiyumva (2003). Welzel and Breuer developed physics activities for pre-service teachers to teach science to street children in Germany. They found that many of the pre-service teachers used teacher-centered models of teaching because that was how they learned in school. They also did not consider the experiences of the students when developing and teaching the activities. The activities would have been more successful if the teachers had knowledge of working with children who experienced interrupted education. Also, the researchers found that students worked best independently for 30 minutes rather than in groups. Another important finding was that quality materials need to be available to complete the activities successfully.

In addition to the work by Welzel and Breuer (2006), Perrier and Nsengiyumva (2003), investigated the use of hands-on science as a play-based therapy for orphaned children in Rwanda. Perrier and Nsengiyumva suggests including the regular classroom educator in the teaching process so that the teacher could continue to lead activities without guidance from the facilitator or researcher. Both studies demonstrate the need for quality materials and volunteer educator training for supporting the teaching of science in non-formal settings to children with interrupted education. It is crucial to improve confidence and attitudes in these volunteer educators because their disposition towards science can transfer to their students (Bandura, 1977; Gunning & Mensah, 2011; Menon, Shelby, & Mattingly, 2016; Tschannen-Moran, Hoy, & Hoy, 1998).

Purpose of the Study

The purpose of this qualitative study is to (a) identify how volunteer educators' backgrounds and experiences in learning and teaching science impact their confidence when teaching the subject to refugees in non-formal settings, (b) how the use of hands-on science kits affects their self-efficacy, and (c) how the volunteer educators perceive the value of science for refugees in these settings. This multi-site case study follows four volunteer educators from three separate sites in Greece as they prepared, taught, and reflected on leading inquiry-based science activities that promote scientific practices in these non-formal learning spaces.

Before this study, I completed two trips to refugee camps in Greece to test and deliver a hands-on science curriculum that I developed for Afghan, Iranian, Iraqi, and Syrian children who have experienced interrupted education as a result of war. Science concepts that were piloted included electricity and magnetism, force and motion, acid and base chemistry, states of matter, and plant biology. The activities for the kits were tested with children aged 5-17 across ten separate non-formal refugee settings during the Winter of 2017 and the Summer of 2017. Activities identified for each of the units were selected based on volunteer questionnaires, observations, field notes, and interviews (Gillette & Halpern, 2018). For this dissertation study, seven hands-on science activities were selected to teach science concepts across two units. The first unit about magnetism and electricity included four activities. The second unit about force and motion included three activities. In addition to the required materials and lesson plans in the kits, there was also a dictionary with science vocabulary and pictures. Native speakers professionally translated the important science terms into English, Farsi, Greek, and Arabic. On these previous trips, I presented the lessons with assistance from volunteer educators. I also provided materials and activity plans to volunteers so that they could teach additional lessons on their own after the field research ended.

From volunteer questionnaire feedback, findings showed that many of the volunteer educators did not feel comfortable teaching science on their own without having a science educator or scientist there to support them. Some of the suggestions they gave for how to increase their confidence and self-efficacy included professional development or online videos in addition to the already provided teaching materials. Therefore, to be able to bring hands-on science to diverse educational settings serving refugees, teachers need proper training and the confidence to teach these lessons.

Research Questions

As both a science teacher educator and developer of science curriculum, I was interested in understanding the experiences of volunteer educators teaching inquiry-based science to refugees. The research questions for this dissertation are the following:

1) What are the experiences and perceptions of volunteer educators teaching hands-on science activities in non-formal refugee education settings?
   a) What kind of preparation and materials do volunteers need to teach science in non-formal refugee education settings?

b) How does the use of hands-on science activities affect volunteer educators' confidence, attitudes, and beliefs towards teaching science?

c) How does a background in science prepare volunteers to teach science in refugee settings?

d) How does the volunteer educator view the value of science education for refugee learners in non-formal refugee spaces?

Chapter II

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter reviews literature on non-formal science education domestically and non-formal education in conflict-affected areas worldwide. The second area of the literature review focuses on teacher preparation in conflict and emergency settings and professional development in science teaching. The chapter continues with literature that investigates the use of science-kits to teach science. Lastly, sections on practice based science instruction and curriculum for new language learners are included.

Science Education in Formal and Non-formal Settings

Formal Science Education in Greece

Science education can be provided in a formal and non-formal context. A formal context usually implies that the material is presented at a school, structured, prepared, compulsory, teacher-led, assessment-driven, and student motivation to learn is extrinsic. Whereas non-formal education is usually at an institution outside of school, also structured, also prepared, also teacher-led, learning may or may not be assessed, and students are intrinsically motivated (Eshach, 2007). The National Research Council (2007) identified some goals and outcomes of non-formal science programs which include developing interest in science, learning of scientific concepts, engaging in scientific practices, and construction of scientific identity.

United Nations Education and Scientific Organizations (UNESCO) first started in November of 1946. The first constitution identified that science contributes to peace and security (Archibald, 2006; Nielson, 2019). Nielson (2019) stated that UNESCO also supports science because it contributes to “global, enlightened citizenry” (p. 246). In Greece, schools have spent the last twenty years developing cross-thematic units that support experiential learning (Aggelakos, 2007). The New Greek Science Curriculum (NGSC) was recently developed in 2013 to improve science education. The goals of the NGSC, according to Plakitsi, Spyrtou, and Kalogiannakis (2013), are “to develop scientific skills, understandings and competencies both inside educational institutions and in all societal 'informal' settings where learning, culture, and social interactions occur” (p. 1). One of the characteristics of the NGSC includes the use of activities to develop technical and inquiry skills. A magnetism and electricity activity developed by Theodoraki and Plakitsi (2013) sought to design inquiry activities for Greek children that were between the ages of five-to-nine years old. They also wanted to see how the teachers created meaningful learning experiences for their students. Using multiple data sources, they found that the activities supported student collaboration, active questioning, and student-centered learning.

Non-formal Refugee Education in Greece

Refugee education often takes place outside of formal school in non-formal learning environments. Similar to non-formal science learning described above, non-formal education is a term used by the Inter-Agency Network for Education in Emergencies (INEE) to describe learning that happens outside of school. According to a report from the Greek Ministry of Education, Research, and Religious Affairs (2017), as a signer of the 1951 Convention, Greece is required to provide education to all refugee children. As a result, some refugee children have been able to attend school in the afternoon. Others, however, have not been able to attend school primarily because of the geographical access they have to schools and the transitional nature of being a refugee awaiting resettlement. According to a report by the Human Rights Watch (2018), refugees in Greece are often living in camps that are located in inaccessible parts of the city or in rural suburbs where it can be difficult for them to get to school. The inaccessibility of schools often leads to them learning in non-formal environments even though they are often dissatisfied with the low-quality education that they find in camps.

Refugees that can attend formal schools face other difficulties. A report completed by the Greek Ministry of Education Research and Religious Affairs (2017) raised a number of concerns. First, Greece has some of the fewest numbers of hours in the regular school day than any other developed country. The few hours designated for teaching refugees in the afternoon are spent teaching the subjects of Greek and mathematics. The teachers in the afternoon classrooms serving refugees generally are substitute teachers who have completed their pre-service courses and are awaiting permanent teaching placements in Greek schools. Many of the teachers lack training in how to engage children who have experienced trauma and how to teach students whose first language is not Greek. Also, because of the economic situation in Greece, there are few resources to support instruction and adequately compensate the teachers. Problems with funding and high teacher turnover have all impacted the quality of formal education for refugee children and have led to high student absenteeism. Personal correspondence with the Head of Education for UNICEF Greece revealed that primary grade science is a subject that is taught to Greek children in formal Greek schools but not in the afternoon classes provided to refugee students (N. Imoto, personal communication, July 14, 2019). Without science being taught in formal school, refugee children often have no formal experiences with science practices or concepts.

Non-formal Science Education for Conflict-Affected Youth

Even though science is academic in nature, it is also a subject that has been investigated as a play-based therapy. For instance, Lederman (2000) pointed out in his testimony before the US House of Representatives that "children trained in hands-on inquiry methods not only learn science, but they experience the joy of learning with consequences much beyond the science class" (p. 1). This statement was evident in a study completed by Perrier and Nsengiyumva (2003) that investigated the use of scientific practice as a play-based therapy for orphaned children in Rwanda. The activities took place at an unaccompanied children center with a population of 300 children/young adults aged 4 to 20. Students engaged in multiple hands-on investigations where they classified objects and identified similarities and differences. The author noted that 100 other children from the center came through open windows and doors to try and engage in the activity. This event led to the center having to create additional activities to keep the non-participants occupied during the sessions. At the end of each session, the students did not want to leave the room or allow the researchers to leave either. These statements suggest that these activities were so engaging and motivating that they brought this joy of learning to these children. Perrier and Nsengiyumva suggested having more opportunities for the children to use simple objects, as many students expressed that this was something they would have liked a chance to do. Also, they would not have used trash or objects from around the camp but rather allow the students to engage with real scientific instruments. Another suggestion that the author made was to include the educator in the process. In this study, the teacher was at the same level as the participants and was learning with the students. By not including the teacher in the planning and instruction, this may have led to the teacher being unaware of the next steps to answer the participants' questions. Thus, there is a need for proper professional development to give background knowledge and science instruction skills to educators in these settings.

At the 2006 annual NARST conference, Welzel and Breuer (2006) presented their work on teaching physics to street children in Colombia. They defined street children as being inclusive of refugees, war-affected youth, and children who experienced interrupted education. The researchers designed physics activities to allow students to gain experience and meaning by experimenting with basic materials, observing outcomes, and communicating what they saw. They stated that "only on this basis will they be able to further differentiate physical objects and their properties to explore them step by step experimentally, and finally to discover and comprehend principles of physics" (p. 2). First, the researchers prepared student teachers to lead the lessons for the children by having them engage in each of the activities. Many of these student teachers did not have backgrounds in teaching children with interrupted education or who experienced war. Many of them described their learning in school as being teacher-centered. As a result, one of the findings showed that when engaging the students in the activities, many of the teachers taught using this teacher-centered model. Unfortunately, the lessons did not go so well. The researchers found that this teacher-centered approach to teaching and learning did not work well within the context of non-formal education for street children.

Another finding was that the children were unable to focus on the teacher for long periods. When working independently, the researchers reported that the children were very focused for up to thirty minutes with the materials. The researchers also found that students preferred having their own materials and working independently rather than in groups. This research supports the importance of using quality materials and knowing the experiences of the child and how it impacts instruction. This study highlights the need for teachers to reflect on how to teach students whose learning experiences may not be the same teacher-centered experience they had and adjust their instruction. Both studies demonstrate the need for quality materials to engage in scientific practice. Also, the studies both show the need for further research in volunteer educator preparation to teach science in non-formal settings for children who experienced interrupted education.

Professional Development in Education in Emergencies and Science Teaching

According to the Global Monitoring Report completed by UNESCO (2015), education in emergencies has received the least amount of funding, while the vast majority of the aid has gone towards food, water, and housing. As a result, 3.7 out of 6 million refugee children receive no education (UNHCR, 2016). The children who do receive an education are often not taught by qualified well-trained teachers.

Teacher training and teacher education in emergency settings has been largely under-researched. The research conducted on teacher education suggests that factors such as strong pedagogical skills, classroom management skills, and learner-centered teacher skills impact the quality of education that children receive (Dryden-Peterson 2011; Mendenhall et al., 2015). Kirk and Winthrop (2016) state that a significant challenge that volunteer educators face when entering the refugee classroom is that they do not have a strong teaching background. Teacher identity, background experience, and self-image are all important when delivering quality education programs. Some barriers for even well-qualified teachers to teach effectively include large classroom sizes with wide-ranging skill levels, the language of instruction, student trauma, inconsistent or lack of salary or incentives, and lack of resources and training (Kirk & Winthrop, 2016). All these challenges and barriers are contextual factors that can impact teacher thinking and practice. Some ways that help teachers feel supported is to create communities with constructive dialogue, have teachers take notes on the lessons and activities, and provide training workshops. Creating a community and providing workshops allows the space to motivate and train teachers who are working in difficult situations (O'Sullivan, 2010).

In science education, providing professional development by learning through inquiry allows teachers to reflect on their teaching and learning in science (Forbes, 2011). Solomon and Tresman (1999) stated that professional development programs need to motivate teachers and relate to the goals they are working towards in their classrooms. There must be an understanding that these educators are professionals and that they reflect on their practice. While doing so, they construct a self-image of themselves as science teachers.

To understand how to prepare volunteer teachers to teach science, we must consider their background and experiences with teaching and learning science. Another consideration is to look at contextual factors that may be barriers to implementation and create a plan to support the teachers in overcoming these obstacles. There must be support, resources, and tools for these educators to use to teach the students. Lastly, volunteer teachers need to be motivated and be able to reflect on their planning and teaching of science within their unique classroom environments.

Science Language Instruction and Curriculum for New Language Learners

The refugee crisis in Europe has brought with it a growing number of children who are linguistically and culturally diverse. Therefore, refugee children coming to Greece may not initially understand the Greek language or culture. Also, much of the subject matter instruction in both formal and non-formal education settings in Greece is not in their native language but rather in English or Greek. For these reasons, it is important to review the literature to understand the best practices for instruction and curriculum to teach science to new language learners. Much of this research is based on research done in science education for populations of students who are English Language Learners (ELLs). However, these recommendations can transfer into a similar context of science education for students who may be receiving science instruction in a language that is not their primary language used at home.

Science is a practice that can provide a meaningful context to support literacy development for New Language Learners (Buxton & Lee, 2014). However, academic language can sometimes be a barrier to instructing students who are learning a new language (Gomes & Mensah, 2016). For example, in a study of resettled refugee learners, Miller (2009) writes about the struggles that teachers have teaching students who have experienced interrupted education. The study looked at eight students and the barriers they had to attain academic language in science. Through journaling and interviews with the teachers, findings showed that when the student cannot understand the language, they experience frustration and become discouraged from learning science. In response to the initial results, Miller (2009) developed the *Science Vocabulary Project*. The goal of the project was to determine if bilingual dictionaries were supportive of the student learning of important scientific vocabulary. They found that in conjunction with labs, the dictionaries supported both the definition and meaning when practiced.

There has been considerable research on teaching science to New Language Learners and which approaches for science instruction work best. The literature highlights that science becomes more concrete and experiential when students are engaged in scientific practice (Buxton & Lee, 2014). There are many reasons as to why hands-on scientific practice is beneficial to New Language Learners. According to Stoddart, Solis, Tolbert, and Bravo (2010), practice-based activities do not require students to have a mastery of the language in which instruction occurs. Second, the practice of science provides students with the opportunity to acquire a new language by putting vocabulary in context. Students can demonstrate their understanding through a variety of means either orally, pictorially, or through writing. Lastly, they highlight that students experience and learn different language functions through the process of hypothesizing, explaining, predicting, and reflecting, while also engaging in activities that support their abilities to observe, describe, explain, predict, estimate, and infer (Buxton & Lee, 2014). It is essential that when guiding students through instruction, the teacher understands the vocabulary that they will be incorporating into their teaching. One suggestion stated by Fathman and Crother (2006) is that the teacher only selects a limited amount of science vocabulary for use in their instruction. Engaging students who are New Language Learners in practice-based science activities allows them the opportunity to demonstrate their learning through multiple representations. Also, these activities support literacy development for New Language Learners when the scientific vocabulary is integrated and taught effectively.

Kit-Based Science Learning

The National Research Council (2012) stated that science is not just the process of learning scientific ideas but also engaging in scientific practice. The idea that students learn through experience and by doing was introduced by John Dewey (1938) as the active learning approach. An active learning environment provides students a space to engage in activities that are relevant to the real-world. The active learning approach is an important tool to support meaningful learning (Bonwell & Eison, 1991). There are many features of the active learning approach used in science outlined by Christensen, Knezek, and Tyler-Wood (2015). These features include relevance to real-world problems, authentic solving of real-world problems, application of prior knowledge and experience to solve new problems, collaboration with others, integration with other subject matter, and self-directed learning.

Active learning has been used as a foundation for the development of science curriculum, specifically pre-constructed science kits. A benefit of pre-constructed kits is that the children are excited to do the activities. This excitement leads to positive student attitudes (Rubino, 1994; Sherman & MacDonald, 2008). Teachers have reported that students who engage in active learning through pre-constructed kits are excited about science class and often look forward to participating in the activities (Sherman & MacDonald, 2008). Positive dispositions can be especially engendered when the activities are made personally relevant to the child (Aschbacher, Ing, & Tsai, 2013; Christensen, Knezek, & Tyler-Wood, 2015; Sharples et al., 2014). For example, Sharples et al. (2014)

studied the development of science kits for middle school and wrote that learning needs to be personally meaningful to the learner. In addition to being personally relevant to the learner, science is more meaningful when the activities are student-centered. This aligns with an attribute of active learning, which states that learning should be teacher-guided and student-centered (Christensen, Knezek, & Tyler-Wood, 2015). Sharples et al. (2014) said that when students are surprised by the outcome of the activity, it supports their scientific curiosity and sense of wonder. This curiosity that comes from engaging in scientific practice leads to a desire for an explanation. This desire drives discovery in both formal and non-formal settings.

There are also many benefits of pre-constructed science kits for teachers. The first benefit is that there is an increase in teachers' science content knowledge, pedagogic content knowledge, confidence, and enthusiasm for science (Rubino, 1994; Sherman & MacDonald, 2008). Another benefit is that kits help teachers feel better prepared for teaching science since the material is often organized and includes lesson suggestions. Engaging in scientific practice when the material is not organized and prepared can be viewed by the educator as time consuming and challenging to manage (Edelson et al. 2019, Quintana et al. 2004; Sharples et al., 2014). By having everything ready and organized, pre-constructed kits allow teachers to have more time to think about how they can modify activities for their students so that they are relevant and meaningful (Sherman & MacDonald, 2008).

Kits are most effective when teachers receive some professional development. Rubino (1994) completed a study of 214 teachers who completed a workshop on the use of science kits. The study showed that 54% of teachers that attended the workshop and used the kits in their classrooms self-reported an increase in their science content knowledge, teaching skills, and attitudes towards teaching science. Another study by Nowinski, Sullivan-Watts, Shim, Young, and Pockanly (2012) had teachers present kit-based lessons to assess the accuracy to which they were taught. They found there was no correlation between teacher content knowledge and their ability to deliver science-kit activities accurately. However, the teachers who provided the lessons with the most accuracy had kit-based professional development and had already demonstrated a preference for teaching science before the study began.

Kit-based science can be a valuable resource for schools that are poorly equipped or isolated (Fetters et al., 2002; Rennie, Howitt, Evans, & Mayne, 2010; Young & Lee, 2005). Rennie et al. (2010) conducted a study on the use of museum provided science kits in rural areas of Australia. They found that teachers with good pedagogical knowledge, but who lack confidence about their own science knowledge, can still use the kit effectively. They found that the effectiveness of the kit depended mostly on pre-activity preparation and planning by the teacher, flexibility of the kit and materials, and providing some professional development. Based on feedback and observations, the researchers suggested that kits used in low-resource settings must be well-organized and clearly labeled, and the activities and worksheets should be able to challenge the children across age levels, contain science knowledge support for the teacher, and a photographic guide with instructions for setting up and conducting the activities.

Theoretical Framework

The Teacher-Centered Systematic Reform (TCSR) model (Enderle et al., 2014; Gess-Newsome, Southerland, Johnston, & Woodbury, 2003) is the theoretical framework and lens for this study. In this model, it is understood that teacher characteristics, teacher thinking, and teaching context all influence one another (Enderle et al., 2014). Teacher characteristics include teacher background and personal factors that may influence their beliefs and thinking about teaching science (Mensah, 2012, 2016; Moore, 2008). Their beliefs and attitudes towards teaching science are often connected to their past experiences with science, their interest, self-esteem, and self-efficacy (Koballa & Glynn, 2007). Often, the amount of science taught and the quality to which it is taught is dependent on elementary teachers' attitudes and confidence to teach science (Gunning & Mensah, 2011; Mulholland & Wallace, 2009; Schoeneberger & Russel, 1986; Wallace & Louden, 1992). In addition to teacher characteristics and teacher thinking, teaching context also impacts teacher practice (Chen & Mensah, 2018). As previously discussed, some barriers in non-formal refugee contexts include large classroom sizes with wide-ranging skill levels, the language of instruction, student trauma, inconsistent or lack of salary or incentives, and lack of resources and training (Kirk & Winthrop, 2016).

There has been much research that looks at the connection between teacher thinking or beliefs and their self-efficacy to plan and teach (Nespor, 1987; Wallace & Kang, 2004). Teacher thinking and beliefs about students, beliefs about teaching, beliefs about inquiry, and beliefs about self are central and influence their self-efficacy and practice (Pajares, 1996). Nespor (1987) argues that teaching is driven more by teacher beliefs than content knowledge. Also, findings show that beliefs about student learning and teacher confidence are two important factors for elementary teachers to be able to teach science (Enochs & Riggs, 1989).

This dissertation study looks at three categories of science teacher beliefs: beliefs about self, beliefs about inquiry and teaching, and beliefs about students and how these influence the self-efficacy of a teacher. Figure 2.1 shows an adapted TCSR framework for volunteers teaching in non-formal refugee contexts. The TCSR framework gives insight into the teaching of science by volunteer educators and the relationship between their science background and beliefs as it applies to their teaching of science kits within the context of non-formal refugee settings.

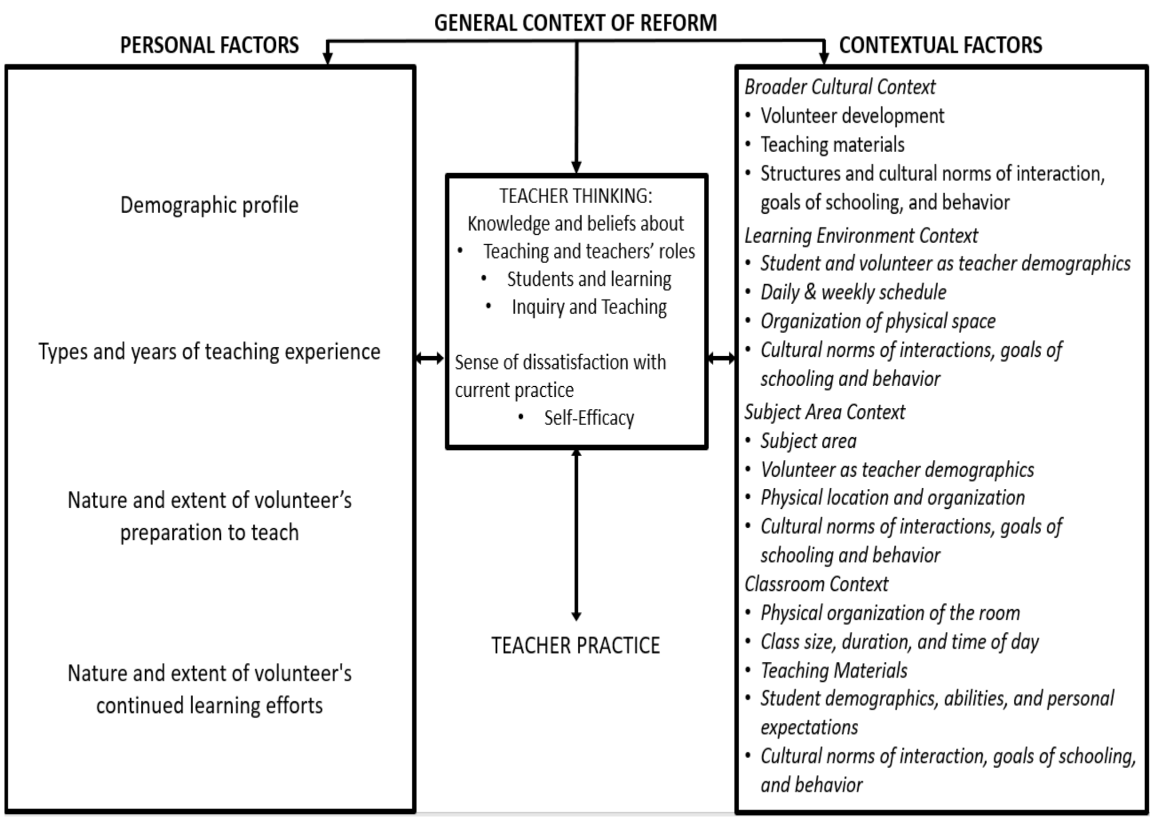

Figure 2.1. Graphic representation of the TCSR model (adapted from Enderle et al., 2014; Gess-Newsom et al., 2003)

Teacher Thinking About Self

Bandura (1997) identified two dimensions of self-efficacy referred to as perceived self-efficacy and outcome expectancy. "Perceived self-efficacy is a judgment of one's ability to organize and execute given types of performances, whereas an outcome expectancy is a judgment of the likely consequence such performances will produce" (Bandura, 1997, p. 21). Perceived self-efficacy is often domain and context-dependent and can change as the context for the task changes (Bandura, 1977). In addition to context, perceived self-efficacy may determine the activities chosen and how they are taught (Gunning & Mensah, 2011). Furthermore, perceived self-efficacy plays a role in the management, planning, and teacher practice (Bandura, 1997). As a result, Bandura stated that high self-efficacy would lead a person to have confidence and behave in a decided manner rather than someone who may become easily frustrated and demonstrate low self-efficacy. Self-efficacy can be observed through the intentional actions of the teacher through their practice and the outcome expectancy.

Bandura (1997) wrote that self-efficacy is influenced by beliefs that a teacher has already developed about their ability to teach. In addition, their own life experiences influence their beliefs about what the outcome will be. He identified four modes of self-efficacy that include: *mastery experience, vicarious experience, verbal persuasion,* and *physiological and affective states. Mastery experience* is considered to provide "the most authentic evidence of whether one can muster whatever it takes to succeed" towards achieving a goal (p. 80). In this mode, individuals may focus on tasks that are doable and raise self-efficacy beliefs. Contextual factors can influence a person's mastery of a task. These factors include the assistance of others, availability of materials and resources, and the context in which the activity is completed (Mulholland & Wallace, 2001). *Vicarious experience* is referred to as "the attainment of others who are similar to oneself are judged to be diagnostic of one's capabilities" (Bandura, 1997, p. 87). Individuals who are inexperienced or uncertain about their abilities may seek a role model that can help them to develop their desired skills. *Verbal persuasion* is a mode where "people are persuaded verbally that they possess the capabilities to master given tasks and are likely to mobilize greater effort to sustain it" (Bandura, p. 101). Therefore, when a person is persuaded that they are capable of performing a task by others, they can have high-self efficacy. Bandura describes the fourth mode, *physiologic and effective state*, as "people are more inclined to expect success when they are beset by aversive arousal than if they are tense and agitated" (p. 106). Physiologic and effective states can also be context-dependent. Arousal can be experienced by either a failure to cope by a person with low-self-efficacy or as a result of perceived success for a person with high self-efficacy.

Teacher Thinking about Inquiry and Teaching

Preparation, choice of instruction for lessons, how lessons are organized, and how to teach the lessons are all informed by the teacher's self-efficacy and their teaching practices (Bandura, 1997). When considering beliefs about inquiry and teaching, it is understood that these beliefs are based on and enacted around how teachers learned science. Outcome expectancy on instructional efficacy is a belief that student learning is the result of effective teaching. Teachers who have low self-efficacy demonstrate the greatest avoidance behaviors and typically spend less time teaching science (Enochs & Riggs, 1989). These teachers also often use books and prescribed lessons when teaching science concepts (Ramey-Gassert & Shroyer, 1992)., Teachers with higher self-efficacy are more likely to incorporate the use of science practices into their instruction (Watters & Ginns, 1999).

Interactive strategies and hands-on activities can also support positive attitudes toward teaching science (Abell & Roth, 1992). Forbes (2011) completed a study that explored teacher beliefs on teaching and learning, and findings showed there was an increase in the teachers' abilities to reflect on the lesson when inquiry-based instruction was used (Forbes, 2011). Volunteers teaching science to refugees may have beliefs about teaching and inquiry that may impact how they use science kits and integrate scientific practice into the teaching of science to refugee learners.

Teacher Thinking of Students

When investigating teachers' beliefs around students, the extent to which a teacher believes that they can influence student achievement also correlates with their beliefs around their teaching abilities (Gibson & Dembo, 1984). Crawford (2007) stated, "Knowledge and beliefs about teaching are entangled, since what one believes about teaching is connected to one's knowledge of his or her discipline, as well as on one's beliefs about how children learn" (p. 616). Educators' beliefs about their students, like their beliefs about teaching, influence how they design lessons and teach. If a teacher has high expectations of their students, they will support their students by asking them questions that require them to think deeply (Crawford, 2007, p. 617). Teachers within the refugee context may also assume a belief around what a student may be able to do in science or what knowledge they hold (Otero & Nathan, 2008).

Therefore, the TCSR framework provides a scaffold to help understand how teacher backgrounds, characteristics, beliefs, thinking, and teaching context influence teacher practice. Teacher characteristics can influence their practice in that the volunteer educator’s background in learning science, training to teach, and understanding of scientific concepts influences how they teach. Therefore, my research looks at the teaching of science by volunteer educators and the relationship between the volunteer educator’s background and beliefs as it applies to their teaching through the use of preconstructed science kits within the context of non-formal refugee settings.

Chapter III

METHODOLOGY

Research Questions

The research questions are the following:

1) What are the experiences and perceptions of volunteer educators teaching hands-on science activities in non-formal refugee education settings?
   a) What kind of preparation and materials do volunteers need to teach science in non-formal refugee education settings?
   b) How does hands-on professional development in science affect volunteer educators' confidence, attitudes, and beliefs towards teaching science?
   c) How does a background in science prepare volunteers to teach science in refugee settings?
   d) How does the volunteer educator view the value of science education for refugee learners in non-formal refugee spaces?

Research Study Design

Research Approach

A qualitative, multi-site case study methodology was used for this study (Merriam, 2009) to capture the experiences and perspective of volunteer educators as they engaged with teaching refugee children in their non-formal learning spaces. My research questions looked at the experiences of volunteer educators and were best answered using qualitative methodology because it provided the opportunity to develop detailed descriptions of the volunteer educators' actions, reactions, and interactions as they planned, taught, and reflected on the activity presented within the non-formal schools and community centers serving refugees. Qualitative methodology also allowed me to assume the role of the researcher. In this role, I was the primary instrument for data collection and analysis. I was thoughtful and focused on how I analyzed the experiences of these volunteers using multiple sources of data. Throughout the process of data collecting, I was able to be reflective while concurrently asking questions and making interpretations (Cresswell, 2009).

A multi-site case study design was used to study four individual volunteer educators as they taught in three separate locations. According to Merriam (2009), a multi-site case study can be used when individual cases are bound by a common characteristic. The characteristic that bound this case study was that all of the volunteer educators used pre-constructed science kits in non-formal settings located in Greece to engage students who have experienced disrupted education as a result of conflict and war. In addition, I worked at one site at a time for a duration of ten days, as suggested by Bogden and Bilken (1992) for a multi-site case study.

Methods

Settings and Participants

Participants for this study were volunteer educators recruited from non-government organizations (NGOs) operating education programs in non-formal education settings serving refugee populations. My relationship with the Head of Education for UNICEF Greece allowed for an introduction to 28 different mainland camps in Greece, where they are supporting educational programming. I selected three sites based on the responses to my initial email request for participants and the volunteer educator profile.

Each of the three sites was located in different areas around Greece. The volunteer educators that were selected came from different countries and had mixed experiences with learning and teaching science. Purposeful sampling was used to choose the best sites and participants that would help me to understand each of their experiences teaching science and answer my research questions. I identified three participants that were educators in their native countries and had teaching experience. Two of the participants, Sarah and Kate, identified that they had a background in science and also in teaching science. One of the teachers, Anna, did not have a background in science and had experience teaching English Language Learners. Throughout the course of the study, I chose to include a fourth participant, Laura, who agreed to participate in the study after Sarah had to leave unexpectedly half-way through. Laura, like Anna, also did not have a background in teaching science but did have experience teaching English Language Learners. By including four participants, I was able to have an even distribution of volunteer educators with and without backgrounds in science. Because the kits were differentiated for use with students ages 5-17, the grade level experience of the teacher was not a criterion for selection. Table 3.1 outlines the participants, the settings that they taught in, and their experiences and background with teaching.

Context for Greece

Greece is a gateway country to Europe (Dimitriadi, 2017) and has many refugees that come mostly from Syria, Afghanistan, and Iraq. As a gateway country, Greece is the first place in Europe where most refugees arrive. As a result of the humanitarian crisis in their home countries, thousands of refugees have fled to Greece through Egypt, Lebanon, Jordan, Iraq, and Turkey (Yassin-Kassab & Al-Shami, 2016). In Syria between the years 2013 and 2014, there were many bombings in the city of Aleppo and neighboring communities. In addition, ISIS was becoming an increasing presence which led to many families fleeing to neighboring countries (Korkut, 2016). In 2014-2015, more than one million refugees made the journey by boat from Turkey to Greece across the Aegean Sea (Clayton & Holland, 2015). The three settings for this study are located throughout Greece where refugees have come by either foot or boat.

Setting 1: Former Orphanage

The first setting was located in a military-controlled camp located in northern Greece. It was a converted World War II orphanage that, at the time of the study, was home to 400 refugees from Syria, Iran, Afghanistan, and Iraq. Each NGO that operated educational programming was allotted two classes a day in the shared classroom. The lessons that were typically taught by the NGO I worked with were English classes. Each class was an hour long, and the classes were separated by language proficiency and age. The beginner class was for children who reported their age as being between seven and twelve years old. The second group was for the children between twelve and nineteen years old. Anna taught at this location.

Setting 2: Urban Community Center

The second setting was a community center located in the center of a large urban city located in mainland Greece. It was run by a small NGO that served refugees from Syria, Turkey, Somalia, and Iran. They provided Arts & Crafts, English, Greek, and German classes throughout the day for young children to adults. Each class was an hour long and was open to whoever wished to attend. Sarah and Laura taught at this location.

Setting 3: School by the Navy Facility

The third location was a military-run camp located in an industrial section by the sea. At the time of the study, 1500 refugees were living there. The NGO operating there taught Mathematics, Greek, and English classes to children 7-18. The children were homogeneously grouped according to their ability levels in Mathematics and their proficiency in Greek and English. The classes were one hour in length. Kate taught at this location.

Table 3.1

Participant Setting, Demographics, and Experience

Participant	Setting	Nationality	Age	Experience
Anna	Former Orphanage	Australian	25	• Montessori trained educator • Teaches English to new language learners • No experience teaching science
Sarah	Urban Community Center	Irish	35	• Experienced teacher who has taught science to fourth grade for six years • Ran science clubs at her school in Ireland • BS in Applied Physics
Laura	Urban Community Center	Australian	57	• Ten years of experience teaching English as a Second Language to adults • No experience teaching children • No experience teaching science
Kate	School by Navy Facility	Greek	35	• Taught STEM as a museum educator seven years • Has been teaching science, mathematics, English, and Greek to refugees and Roma children for three years • MS in Biology Education

Procedures

I worked at one site at a time for a duration of ten days as suggested by Bogden and Bilken (1992) for a multisite case study. The first day of the ten days was spent completing the initial interview. The professional development sessions were completed at each site on the second day which was the day before the first activity was taught. As the researcher, I provided each volunteer educator with activity guides, videos, and a three-hour professional development session. The sessions occurred at the community center or in the classroom during non-teaching hours. The sessions were completed one-on-one. During the session, the volunteer educator completed all seven activities found in the two kits and developed a plan for teaching the activities in their classroom. The kits contained everything that was required to teach the activities and were aligned to Next Generation Science Standards (NGSS). Pictures, alignment to NGSS, and descriptions of the activities can be found in Appendix A.

I spent a total of one-month across all sites. As discussed, two of the ten days at each site were for the initial interview and professional development session. Seven of the days were for the teaching of each of the seven activities. Thirty minutes before each activity session, the volunteer educator set-up the activity and reviewed the plan that they wrote in their pre-activity journal. During this time, each of them were able to add more notes or make changes. Activity sessions at each of the sites were one hour and allowed for the teaching of one activity in each of the units. After leading each activity, the volunteer educator completed the post-activity journal. Following the fourth activity session, there was a semi-structured interview with each of the participants. Questions were selected based on the responses to pre and post activity journals, observations, and any informal discussions that I wanted to know more about. Lastly, there was a semi-structured final interview the day after the last activity session. The final interview sought the volunteer educators' perspective on all of the activities, what they noticed about the students during the activity, any questions that arose from the observations, and follow-up questions from the pre-and post-activity questionnaires.

Data Collection Methods

Before data collection, I received IRB consent from participants. For this qualitative study, data was collected through multiple sources to develop a clear narrative of the experiences of the volunteer educators teaching science in non-formal refugee settings. The data sources included a pre-activity questionnaire, pre-activity journals, observations, post-activity journals, a post-activity questionnaire, and interviews. The data collection table (Table 3.2) outlines the data collection method and the type of data collected.

The data was not collected anonymously. The volunteers provided their names for their journals and questionnaires, which were coded with identification numbers after I received the data. Only I had access to the codes for confidentiality. This allowed me to link the data with the volunteers.

Pre-activity Questionnaire

Participants provided their names on the questionnaires and journals; the names were redacted and replaced with code numbers and pseudonyms after the data were collected. Only I had access to the codes which are stored in a separate and secured file. Two weeks before participating in the study, participants completed a pre-activity questionnaire that was sent to them through email as a Google form. The questionnaire had the participants report their age, the location of their camp or non-formal setting, and their experiences with learning science in elementary, middle, high-school, and in university. In addition to the experience with learning science, they were asked about their experiences teaching science. The questionnaire also asked the volunteer educators questions about their student population, their confidence with teaching science, and their initial beliefs about the value of science for their students. This data provided some background on the volunteer educator's experience and beliefs around teaching and learning in science, in addition to their beliefs about their students (Pre-activity Questionnaire, Appendix B).

Pre-activity Journals

The volunteer educators were part of a professional development session where they participated in doing each of the seven hands-on activities across the two units. The Magnetism and Electricity unit had a total of four activities, and the Physics unit had a total of three activities. The professional development sessions were completed one-on-one with me at each of the sites. After each activity was completed during the professional development session, the volunteer educators had fifteen minutes to record their initial plans for how to teach the activity, their concerns about the activity, and what they were most excited about for the activity. These pre-activity journal pages were provided to them with a prompt. They were able to take the pre-activity pages with them after the professional development session so that they could continue to edit them if they liked. The data from this activity provided insight into the background of the teacher, teacher thinking, context, and any perceived difficulties they believed they would have had with the lesson (Pre-activity Journal, Appendix C).

Post-activity Journals

For fifteen minutes at the end of each day's activity, the volunteer educators completed a post-activity journal and reflected on the activity using a given prompt. They wrote or typed their responses to reflect on how they felt the activity went, what they learned from the activity, and how they would modify the activity in the future. The data from this activity provided insight into the background of the teacher, teacher thinking, practice, and context (Post-activity Journal, Appendix D).

Observations

I observed the volunteer educators teach each of the activities as an observer participant. According to Saldena and Omasta (2018), the researcher as an observer participant can be used to observe and listen to people while they act, react, and interact within their natural setting. In this position, the teacher was aware of my activities and I was able to observe and interact without participating (Merriam, 2009).

It was important to be structured in the observations to minimize the subjectivity of what is observed (Merriam, 2009). Elements that were observed were the physical setting, the participants' role in the classroom, the activities and how they were structured, interactions that the volunteer educator had with the children, conversations, and any less obvious factors (Merriam, 2009). The data from this activity provided insight into the background of the teacher, teacher thinking, practice, and context (Observation Protocol, Appendix E).

Interviews

According to Mirriam (1998), interviews are often used to ask questions about what cannot be observed. Some things that cannot be observed are feelings, thoughts, and intentions. A semi-structured, three-interview series was used for this study (Patton, 1990; Seidman, 2006). This format was selected because it allowed me as the researcher and observer-participant to discuss experiences within the context as it occurred. Semi-structured interviews provided a flexible but structured approach to interviewing (Omasta

& Saldana, 2018). I developed a list of questions that allowed me to cover all of the areas that I was interested in knowing about in regards to the volunteer characteristics, beliefs, teaching context, and practice.

According to Siedman (2006), the first interview of a three-interview series establishes the context of the volunteer educator's experience. In this interview, I asked the volunteer educators to follow-up on some of the questions from the pre-activity questionnaire and helped to establish rapport. The second interview allowed the volunteers to reconstruct details within the context. This second interview occurred after the fourth day of activities. During these interviews, I asked them semi-structured questions about the activities, what they noticed about the students during the activity, any questions that arose from the observations, and follow-up questions from the pre-and post-activity questionnaires they had completed up until this point. The questions asked during the final interview were used to assess the teaching of the activities and changes that should be made in the future to better support the teaching of science in non-formal refugee spaces. The third interview allowed the volunteers to reflect and make meaning of their experiences. The questions from this interview again sought to understand the volunteer educators' perspective on all of the activities, what they noticed about the students during the activity, any questions that arose from the observations, and follow-up questions from the pre-and post-activity surveys. The final interview happened at the end of the research period. Interviews were recorded to preserve everything for analysis (Merriam, 1998). The interview data provided insight into the background of the teacher, their thinking, their practice, and the teaching context (Interview Protocol, Appendix F).

Post-activities Questionnaire

The volunteer educators completed a final questionnaire with open-ended responses. They responded to a given series of questions about the activities and how the materials could be improved for the future. The post-activities questionnaire data provided insight into the background of the teacher, their thinking, their practice, and the teaching context (Post-activity Questionnaire, Appendix G).

Table 3.2

Data Collection Table

Name of Activity	Number of Times the Activity Occurs per Participant	Duration of Activity per Instance	Total period of Active Participation per participant	Data Collected
Pre-activity Questionnaire	1	30 minutes	1 day (given two weeks before teaching activities)	• Teacher background • Teacher thinking • Teaching context
Pre-journal Activity	7	15 minutes	1 week (before each lesson)	• Teacher Background • Teacher thinking • Teaching context
Observation	7	45 minutes	1 week (during each lesson)	• Teacher Background • Teacher thinking • Practice • Teaching context
Post-activity Journal Activity	7	15 minutes	1 week (after each day's lesson)	• Teacher Background • Teacher thinking • Practice • Teaching context
Semi-structured Interviews	3	30 minutes	3 days (first day before professional development session, after first three days of activities, last day after all activities have been taught)	• Teacher Background • Teacher thinking • Practice • Teaching context
Post-activities Questionnaire	1	30 minutes	1 day	• Teacher Background • Teacher thinking • Practice • Teaching context

Data Analysis Methods

As stated by Patton (1990), "each qualitative study is unique, the analytical approach will be unique" (p. 522). Inductive research strategies were used to compare data to identify themes continually. By utilizing inductive research strategies, I was better able to understand and explain a phenomenon that current research has not yet developed an understanding of (Charmaz, 2006). For each participant, the data sources were organized and read through to provide overall meaning. Each of the sources was coded by hand to identify themes that emerged using the TCSR framework as a lens to understand the process and outcomes related to teacher characteristics, teacher beliefs, and teaching context on their practice. I then interpreted and made meaning of each of the themes across each of the data sources to develop a narrative account of the experiences for each case (Figure 3.1). A cross-case analysis was then used to identify themes across each of the cases in order to understand how the cases were similar or different in relation to teacher characteristics, teacher beliefs, and teaching context on their practice.

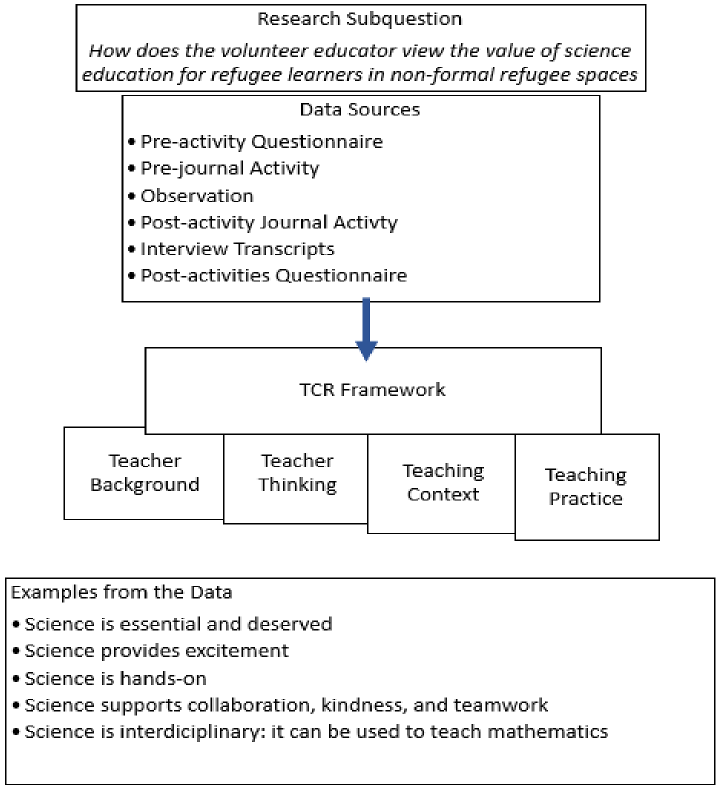

Figure 3.1 Data Analysis Process

Elements of Rigor

For this study, I utilized multiple strategies to ensure rigor and trustworthiness, as suggested by Creswell (2013). These elements included triangulation across multiple data sources to identify common themes. I also continuously evaluated, analyzed, and interpreted the data throughout my time with each participant. This allowed me to continually clarify or make further observations while still in the field (Guba & Lincoln, 1989). Also, I presented and analyzed the data in an attempt to provide detailed descriptions of the setting and events to set apart any perceived researcher bias by ultimately allowing the reader to draw their conclusions.

Data corpus also can enhance rigor and trustworthiness when both participant observation and interviews are used along with other data collection procedures (Omasta & Saldaña, 2018). This is because it can sometimes happen that what a participant says in a questionnaire or interview may contradict what they say and do in the setting.

Ethics and Reflexivity

This was a minimal risk study. Therefore, the harms or discomforts that the participants may have experienced were not higher than they would ordinarily encounter in daily life while taking routine physical or psychological examinations or tests. Participants did not have to answer any questions or divulge anything they do not want to discuss. However, all of the participants were engaged throughout the interviews and answered all of the questions. The volunteer educators were also able to stop participating in the study at any time without penalty. During the study, one of the participants had to leave half-way through due to extenuating personal circumstances in their home country. A second volunteer educator took her place. As a result, I included both this participant and their replacement in this study. The number of participants was supposed to be three across three separate sites but instead ended up being four participants across three sites. There were also no direct benefits to the volunteer educator for participating in this study. They were not paid to participate but did receive materials and professional development to support the teaching of the activities

Researcher Positionality

My experiences and self-efficacy as a science educator have progressed over time. My first experience with teaching science did not occur until I was in my second year of teaching children who had experienced trauma. These students were placed in a residential facility with self-contained classrooms that had a ratio of six students to one teacher and one paraprofessional. I was asked by the principal to pilot a science curriculum called Full Option Science System (FOSS). FOSS is a curriculum that provides preconstructed science kits and curriculum materials for teachers to use in their classroom.

Initially, I did not feel confident teaching science. Although I had low self-efficacy toward teaching science, I now see that it was a result of my own experiences with learning and teaching science. I did not engage in hands-on science as a student, and even my experience as a preservice teacher was devoid of any practice-focused science methods courses or instruction. I saw that engaging in scientific practice was something that benefited the children I worked with. Many of my students had low instructional levels in both literacy and mathematics. I found I was able to teach literacy and mathematics concepts through science activities.

I continued teaching at this residential school for the next three years as the departmental science and mathematics teacher. During this time, I learned how to differentiate and align mathematics and science concepts to meet the diverse instructional levels in the classroom. I was asked by school administration to be the mathematics and science coordinator for the school. During this time, we transitioned to having the individual homeroom teachers teach science in their own classroom. I was responsible for providing professional development and collaborating with teachers to modify the mathematics and science concepts to meet the needs of their students. During this time, I noticed that some teachers were reluctant to implement and lead the science lessons. I found that by having them do the activities prior to teaching, they expressed feeling more confident to teach using the FOSS kits.

I transitioned from working in a formal setting to working in informal science settings when I cofounded an outreach program in Harlem, New York City. I developed a practice-based curriculum to be used in after-school and summer camp programs. I developed over 200 practice-based science lessons that were taught by preservice and inservice teachers that were employed by this outreach program. At the beginning of each week of the camp, we would meet as a group and do each of the activities, and the teachers would plan for their individual classrooms. Unlike the teachers that I had worked with at the school, these teachers had expressed confidence in their ability to teach science. Many of them had Bachelor's degrees in areas of science and were pursuing or had degrees in teaching science. I have always been interested in understanding how backgrounds in science inform instruction as a result of my many experiences in diverse settings teaching and supervising science.

In the Summer of 2016, I learned about the refugee crisis happening in Greece. A colleague of mine and I decided to apply for a fellowship to bring science to refugees. The development of the science kits was supported through a fellowship from a foundation whose vision was to expand educational opportunities for children who have experienced conflict and war. Using the funding, I made two more trips before my dissertation to pilot activities and eventually developed two kits (Magnetism and Electricity & Force and Motion). We first contacted and worked with local NGOs to understand what background volunteer educators had and to pilot some of the science activities that I had created for informal summer programs back in Harlem. I was also interested in understanding what science education practices and activities are best within this context.

Once we received the funding, we made our first trip to Greece in January 2017. My colleague, who is from Iran, was able to ask questions and translate student understanding from the activities in their own native language. We also interviewed the volunteers who participated in observing the lessons about the feasibility and use of the activities and use in their classrooms. We found that a majority of the volunteers at the beginning of the crisis did not have a background in science or experience teaching. Instead, they were provided by the NGO with some professional development on how to teach mathematics and English.

After this trip, we identified a set number of activities based on the responses from children and from the volunteers. As a result, I modified the kits based on my observations and feedback from the volunteers, children, and co-researcher. I returned to three different refugee camps in Greece in the Summer 2017 to test the completed curriculum and continue developing an understanding of volunteer backgrounds and the context. I also found that many of the volunteers in the summer had limited experience with teaching science, but there were some volunteers with teaching backgrounds. Feedback was positive from the students and volunteers about the science activities which reinforced that it was something that could be used within the context of a refugee camp. In addition, volunteers expressed that they lacked the confidence to teach the activities without prepared materials, videos, or professional development. Therefore, I developed a hands-on professional development session to introduce the science activities to volunteer educators who may or may not have a background in science. I also developed the prepared kits to distribute to volunteer educators for them to implement in their classrooms.

It is important to discuss my positionality because my own experiences with learning and teaching science have evolved over time and so has my own self-efficacy to teach. I had also spent a significant amount of time and energy developing the curriculum and materials for the science units. It is important that I took this into account and be mindful of this while I was conducting the research.

A multi-site case study approach was used to understand the experiences of volunteers teaching science using a kit-based, researcher development curriculum in a non-formal refugee context. Chapter IV provides a narrative case study description of the teaching experiences for each case as they planned, taught, and reflected on their science teaching practice.

Chapter IV

FINDINGS

Overview of the Findings Chapter

The first section of this chapter provides a description of two of the activities that the volunteer educators completed. These are presented through narrative descriptions of each individual case for each of the four volunteer educators. The second section presents six major findings that emerged from the data analysis process as they apply to the research questions. At the conclusion of each findings section is a data table that provides a summary of the findings. The chapter concludes with a summary for each of the cases leading to a discussion of the findings, which is Chapter V of the dissertation.

Descriptions of Activities Used in the Study

For this research, I analyzed two activities that the volunteer educators completed during my time with each of them. Each participant and site are presented as a case. Since there were a total of seven activities that they completed throughout the Force and Motion and Magnetism and Electricity units, I focused on their planning, teaching, and reflecting for two activities, one from each of the units. I selected these activities because the volunteers had reported the most about them across their data sources. In addition, I reported on their overall reflections after the teaching of all seven activities. For two of the volunteer educators, Anna and Sarah, I analyzed their teaching of the car and ramp activity from the Force and Motion unit. For the other two volunteer educators, Laura and Kate, I reported on their use of the circuit activity found in the Magnetism and Electricity unit.

Car and Ramp Activity

The materials that were provided to all of the volunteer educators in the kit for this activity were toy cars (one for each child in the class), small medicine cups placed at the top of the car to hold weights (one for each child), a bag of metal washers that served as weights (four for each group), a small piece of rigid cardboard to be a ramp (one for each group), a mat with a metric ruler and also a non-standard ruler with small cubes to count (one for each group), a roll of paper tape to tape the cup to the car, a clear plastic one-quart container to hold up one end of the ramp to keep the incline constant (one for each group), another clear plastic one-quart container with a door cut out that goes at the other end of the ramp for the car to roll into (one for each group), and a data collection table. Figure 4.1 shows the set-up for the car and ramp activity.

Figure 4.1 Image of the Car and Ramp set-up.

Each of the volunteer educators participated in a professional development session prior to the teaching the two units to the children in their classes. During the session, the participants practiced the set-up of the activity by taping the medicine cup securely to the center of the car. They then released the car from the top of the ramp with different numbers of weights and measured the distance the plastic cup with the door traveled on the mat when it was pushed by the toy car. They completed the data table where they all indicated that as the number of weights increased, so did the distance that the car traveled. After completing the activity, they spent fifteen minutes completing the pre-activity journal where they discussed how they planned to teach the activity, concerns that they had, and what they were most excited about when leading the activity.

Circuits, Insulators, and Conductors

The circuit, insulators, and conductors activity was the second activity in the Magnetism and Electricity unit. In the first activity, the children learned about magnets and what was attracted or not attracted to a magnet. After testing different materials, they observed that the objects that contain iron or steel were attracted to the magnet and that other metals, like aluminum, were not. The materials provided to all of the volunteer educators in the kit for the circuits, insulators, and conductors activity included pre-wired LEDs (one for each student), a piece of cardboard (one for each student), two pieces of tape (one for each student), a CR2032 coin cell battery (one for each student), and class sets of test materials that were also used for the magnet activity (rubber bands, pipe cleaners, steel screws, plastic chips, steel washers, wooden craft sticks, rubber erasers, brass fasteners, steel paper clips, plastic-covered steel paper clips, small pieces of aluminum foil), and a data collection sheet. Figure 4.2 shows the set-up for the insulator and conductor activity.

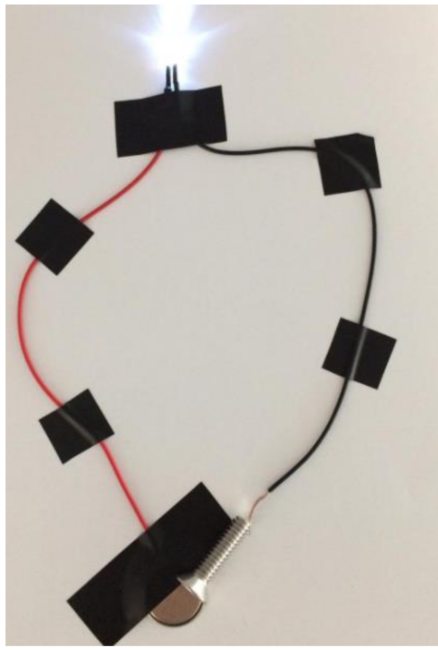

Figure 4.2 Image of the insulator and conductor tester.

During the professional development session, the participants learned about how circuits worked. They each practiced lighting up their LED, taping the LED and battery to the cardboard, labeling the different parts of the circuit (light/lamp, wire, and battery), and testing objects to determine if they were insulators or conductors. They also completed the data table where they indicated which items allowed electricity to pass through them and turned the light on (conductors) and what items did not allow electricity to pass through and did not turn the light on (insulators). Similar to the other activities completed during the professional development sessions, they spent fifteen minutes completing the pre-activity journal where they discussed how they planned to teach the activity, concerns that they had, and what they were most excited about when leading the activity.

Introduction to and Experiences of the Volunteer Educators

Anna at the School in the Converted Orphanage

Anna was a 25-year-old female from Australia. She had six-months of experience teaching in a Montessori school and twelve months of experience teaching English to adults at a private language school in Australia. Prior to her work in the camp, she had also worked with resettled refugees in Melbourne through a homework club. She had been at the camp teaching English classes twice a day for last two months. At the conclusion of this study, she only had one more week of volunteer teaching and was set to leave soon after the study was completed. When asked about her background and experiences with science, Anna reported both in the pre-activity questionnaire and in interviews that she had taken chemistry and biology until the age of 15. She further discussed that she wanted to be a doctor until she had a terrible science teacher in ninth grade and her grades dropped. That was when she left science in favor of humanities.

In a town located in northern Greece, just opposite the Macedonian border, is a converted orphanage from World War II. This former orphanage is now home to 400 refugees from Syria, Iran, Afghanistan, and Iraq. After driving through the heavy steel door and checking our passports in, we are directed by the military police to park and walk up the steep dirt and stone path to the building that is seen on the horizon. As you approach, you can see that the surrounding buildings that house families are in disrepair. Outside the windows hang fading clothing, bedsheets, and towels waiting to dry.

Continuing on, there are community gardens where lettuce, corn, and beans are growing. The makeshift bamboo pole and string fences do little to keep out the stray dogs that can be seen wandering around. Children run around laughing loudly and eager to race to the top of the hill. Once at the top of the hill, Anna secures the key for the classroom from the office at the front of the building. Since the classroom is used by many NGOs throughout the day, it is important that there is a centralized location and a protocol for the signing in and out of the key. Behind the office is the quad. On either side of the quad, there is a small medical center, a large auditorium, and a classroom. The medical center provides families with routine medical care that is provided by doctors that volunteer with larger NGOs. The auditorium is a large space that is often used for movie nights or performances by circus groups or magicians who volunteer to come and entertain the families and children on the weekends. Directly to our right, is a small path that leads to the door of the classroom. The classroom is a warm inviting space with four long tables. On either side of the tables are benches. Two small chairs with attached desks are found at the back of the classroom. At the front of the classroom there is a long table for the teacher that separates them from the students. On the wall at the front there is a whiteboard that has the markings still on it from a previous English class. The classes that are typically taught are English classes. There are two English classes a day taught by Anna. Each class is an hour long and the classes are separated by language proficiency and age. The beginner class is for children who have reported their age as being between seven and twelve years old. The second group is for the children who report their ages between twelve and nineteen years old.

The car and ramp activity was completed by Anna with the beginner group. Prior to engaging with the activities in the professional development workshop, Anna wrote in her pre-activity questionnaire that she was feeling “great” and “excited” about leading the science activities. During the professional development session that she attended with fifteen other participants two days before, Anna practiced the set-up of the activity by taping the medicine cup securely to the center of the car and practiced releasing the car from the top of the ramp with different numbers of weights and measuring the distance the plastic cup with the hole traveled on the mat when it was pushed by the toy car. During the reflection part of the professional development session, Anna wrote in her pre-planning journal how she felt about teaching this activity and how she was planning to teach it to the students:

> Apart from not understanding force myself so well, I have few concerns about this lesson. I think the kids will relish this and really excel. The main concern is the kids will certainly fight over the car colors, but I can make it clear to them that they simply do not get a choice, and if they fight or are upset, they can choose to participate with the car given, or leave.

She indicated in her pre-planning journal and in interviews that she planned to introduce the concept of distance, weight, and force. She planned to introduce the distance vocabulary of “long” and “short” and weight as “heavy and light.” She indicated that she would introduce the concept of “force” without using the word. Instead, she would demonstrate force by showing that the car with no weight pushes an object a short distance while a car with weight pushes the object further. She planned to introduce the concepts and vocabulary using physical demonstrations in front of the class. After releasing the car from the top of the ramp she planned to show the children the ruler and the distance the car traveled. They would then count each centimeter together. In addition, she wanted to select one student to count the squares on the non-standard ruler in front of the class to demonstrate that both centimeters and the squares were the same.

Anna also indicated that the students would draw a table in their notebook by copying it from the board. As they copied, she planned to assist the class in copying the table and ensure that they all understood it before proceeding to the experimental set-up. For the set-up, Anna stated that she would give students the mat after putting them into groups of two or three. She would then give students the plastic containers with the hole cut out and the other without. She would then demonstrate where on the mat they should go. Next, she wanted to give each group a ramp and a car. She indicated that she would then have the kids sending the car down the ramp with no weights. After they completed the first try, they would record the results. She then planned to distribute the cups, one of the weights, and the tape. She wanted to demonstrate the taping of the cup before having them do it. The students would then release the car with one washer. After they completed the trial with one, they would receive a second washer, a third, and a fourth. She planned to ensure that all results were recorded before allowing for free play.

When planning out her activities, Anna identified in her pre-activity journal that she was going to first discuss terms such as “long” and “short” and “heavy” and “light.” She modeled this with her hands during the lesson syncing the words “long” with her hands spread far apart and “short” with her hands closer together. She then had the students respond after her and demonstrate “long” and “short” with their own hands. She then modeled the words “heavy” and “light” by acting out carrying a heavy box from the table and lifting a smaller object effortlessly while pairing the words “heavy” and “light” with each action. Next, she demonstrated using a ruler to practice counting the non-standard blocks and having the children count along with her. She drew a table on the board and had the students copy the table into their notebooks. She demonstrated step-by-step the activity and how to complete the table using zero weights. She gave the materials out one-by-one to groups of three students.

First, she gave the students the cups and had them tape it to the car as she had previously demonstrated. She had the students close their eyes before selecting a car because she did not want them arguing over the color car they received. Then she gave the students the two large containers, ramps, and rulers. After they completed the setup, she had them practice sending the cars down the ramp into the garage and measuring the distance the cup traveled. During the activity, some of the mats and ramps moved so she distributed tape to the group and suggested that they could tape them down. After all the groups had experimented with zero weights, she handed out one weight to each group. After they measured with one weight, she gave them a second and eventually a third. She made sure that all of the results were recorded and then gave the students a few minutes of free play.

In her post-activity journal after teaching the car and ramp activity, Anna wrote:

> This lesson went really well, in my opinion. The kids were fantastic, pre-empting what was coming and experimenting by putting different items in the car "weight bucket." There were only a couple of complaints with the cars (the kids closed their eyes and picked one car from the bag, and couldn't change, which seemed to work). We need to use tape for the sheets and the ramps, as they kept moving. The kids themselves figured out how to do this, which was amazing.

During an interview, Anna stated that she was also surprised by her students' behaviors during the lesson and said, "Hasam, the students who wanted to tape down everything. I was so impressed by how focused he was and really seeing how smart he is." She also commented, "They (the students) were much better today than they normally are." Anna also reflected on how she felt after teaching the car and ramp activity and wrote in the post-activity journal that she felt "great- much more comfortable and excited by it than I'd predicted."

After the teaching of all the activities, Anna reflected in the post activities questionnaire that she noticed:

> The students were, for the most part, easier to hold the attention of than normal, as they were so thrilled by the new material. They also were actively engaged with experimenting and wanting to push it further, which was thrilling to see.

She also reflected on her own practice by saying in her post-activities questionnaire and in an interview:

> I didn't think I was prepared before actually doing the lessons. I was fairly convinced that I didn't understand science well enough to teach it, and that I would absolutely forget things as we were going as a result. However, it turned out to be much more straightforward and self-explanatory than I'd realized.

Prior to teaching the activities, Anna wrote in the pre-activity questionnaire that she thought science would be beneficial to her students because "it sparks curiosity about the natural world, and is often tactile/kinesthetic learning." After teaching the activities, she wrote in her post-activity questionnaire that science is "very beneficial." She noted how students "clearly want to be learning this sort of material and aren't getting the chance. With resources, it would be wonderful for them to have a whole separate science class." When reflecting on her experience as a volunteer educator at the camp Anna said in the final interview:

> The most important thing I've learned is that in this context, learning discipline and writing exams is far more important than in a standard, Western context. More than any other kids I've worked with, these kids lack structure, and further, they actually need exams just to stay in the country and be able to get a bottom level job, let alone the jobs and degrees they would have had access to if they had been able to stay in their own country or been born in another. But they are bored- extremely so. And with boredom comes all levels of troubled behavior, including

> violence. Exciting and stimulating classes, like the science class, provided substantial relief. So, on the one hand, they need classes to prepare them for the reality ahead-on the other, they need something to inspire them to reach that reality.

Sarah at the Community Center

In the center of a large urban city located in mainland Greece is a small NGO that serves refugees from Syria, Turkey, Somalia, and Iran. The mission of this NGO is to provide hygiene supplies, baby care items, education, and food for displaced persons through their community centers. After taking the metro to the local station, I walk through the maze of streets looking for the address that they had given me. I come to a large street filled with vendors selling fruits and vegetables. Many of the entrances of the buildings are blocked by these vendors. Between two of these vendors' tents, there is a line of children and their caregivers climbing down into a subterranean converted office space. A large sticker with the logo of the NGO is stuck over the sign that had once belonged to a former travel agency that had previously occupied the space. Once getting down the stairs, there is a large room that is sectioned into different areas using bookshelves and tables. Resources are limited and the center is reliant on donations from citizens in the community in order to continue to operate. They recently received some school supplies from a school in America and the supplies were well organized in bins that were stacked along the wall. There are two areas with whiteboards. One of the areas is for adult learners and the other is for teaching children. The educational classes that are usually taught are Arts & Crafts, English, Greek, and German. Children must be brought by a caregiver who either stays or more often they leave them and return an hour later to pick them up. The set-up in the children's learning area is made of three long tables that are put in a u-shape with the educator sitting on the opposite side facing the students with the whiteboard directly behind them. The whiteboard in the children's area has an advertisement for the science class that was posted the week prior.

Sarah was a 35-year-old female teacher from Ireland. She had taught all subject areas, including science, to fourth grade for six years. In addition to teaching, she ran science clubs at her school in Ireland. Prior to her work with refugees at this urban community center, Sarah worked with refugees in Ireland and Calais. Sarah's background and experiences with science during her own school experiences were reported as always fun and engaging. She explained that she was always experimenting in a hands-on way. Sarah also holds a BS in Applied Physics from a large university in Ireland.

Prior to engaging with the activities in the professional development workshop, Sarah wrote in her pre-activity questionnaire that she was feeling "a little nervous, but mostly excited." The professional development session was conducted one-on-one as she was the only volunteer educator they had at that time. A second volunteer educator, Laura, would fly in the next day. Sarah had also just received news that she had to return home earlier than expected and that Laura would be taking over the class for the next week forward. During the professional development session, we reviewed each of the activities from the two units and Sarah completed the pre-activity journal after each activity.

During the reflection part of the professional development session, Sarah wrote in her pre-planning journal how she was feeling about teaching the car and ramp activity. She stated that one concern she had was "what age groups will turn up and what time." Another concern that she expressed was that the children "may not understand my instructions", and she was concerned about "behavior management." When reflecting on what she was most excited about for leading the car and ramp activity she said she was excited to "open up excitement and interest for science" and "for children having the opportunity to learn through play." Sarah indicated in her pre-planning journal and in interviews that she planned to begin the activity by explaining "mass" and "force." She then planned to "ask students questions and elicit responses." She emphasized in her pre-activity journal "DON'T REVEAL ANSWER!" Next, she planned to model the setup and charts for recording. She explained that she would then "model one run with no weights and record results together after modeling how to measure." Students would then "work in groups or independently but with support when needed."

The car and ramp activity was completed by Sarah with five children who had varying levels of English proficiency and were between five and nine years old. She began by asking students if they knew what "science" is. The students indicated that they had no knowledge of what it was. She told the students, "today you are going to do an experiment." She had the students clap out the word "experiment" and then each student took turns saying the word. She showed and read the question that they would be investigating on the board: "How far does a car travel with different number of weights?" She then showed students "shorter" and "longer" with her hands. She also introduced the word "mass" by showing an empty container and a container with washers. She continued to demonstrate mass by putting the washers in a plastic bag and having an empty plastic bag. The students practiced saying and clapping out the word "mass." She told the students the definition of "mass" was "how much is in something."

Next, she showed and named each of the materials that they would be using for the activity. She modeled the setup of the ramp on the mat and how to attach the cup to the car. Students worked independently since there were enough setups for this. She modeled releasing the car from the top of the ramp and sending it into the "garage." She showed them where on the ruler it landed, and they worked together to count the distance that the car had traveled. She then asked the students to predict: "What do you think would happen if there were more weights?" The children did not know so she gave them each a washer to test it on their own. They then measured and added the distance for one washer to the chart. Sarah repeated her original question showing them two weights and the students predicted that the car would travel further. Throughout the activity, Sarah referred to the children as "scientist" and stressed that "scientists need to be consistent" when demonstrating how to measure the distance that the car traveled. After completing their data tables, the students shared what they found. Showing them the data, she asked them how far they thought the car would travel with five washers. The older children were able to identify a pattern and make an accurate prediction. The younger students predicted a higher number than there was for four washers. At the end of the activity, Sarah asked the kids "what scientific fact did you learn today."

In her post-activity journal, Sarah reflected on teaching the car and ramp activity writing that it was a "very enjoyable lesson that children seemed to enjoy." During an interview, Sarah stated, "I would drill distance language more at the beginning." She also suggested that it may be "beneficial to provide a step-by-step guide for others so as to make it less intimidating." She gave an example of what this would look like:

Step 1: Introduce mass and force

Step 2: Tell children "we will be experimenting with how mass and force work together."

Consistent with her pre-activity plans, Sarah would have liked to have included more free play at the end to allow children opportunities to make additional discoveries.

After teaching all the activities, Sarah reflected in the post-activities questionnaire that she "noticed the kids' excitement, focus, interest, and gratitude when they realized that they could keep the items to experiment further at home." She also reflected on how prepared she felt to lead the activities in her pre- and post-activities questionnaire, her pre-activity journals, and in interviews saying that she felt unprepared because she "had no idea who was coming" and "if they even knew what science was." She did express that she felt prepared because she had "lots of pre-organized tools and resources." After teaching the activities from the Force and Motion unit, she described how she felt about leading the activities, stating she felt "Great. It was very enjoyable and the children adored the experience. It was fantastic to see them get so excited about the experiments and then begin to develop them further by themselves."

Prior to teaching the activities, Sarah wrote in the pre-activity questionnaire that she thought science would be beneficial to her students because "it's great to expose children to the fun of science and also get them thinking and investigating." After teaching the activities, she wrote in the post-activity questionnaire, "I think it's a great opportunity to open their eyes to the fun of science and build enthusiasm for it when it might not otherwise be available to them. I also think it's just a lovely experience for them, and that in itself is worthwhile!"

Laura at the Community Center

Laura was a 56-year-old female from Australia and arrived as Sarah returned to Ireland because of an emergency. She spent the first three days observing Sarah teach before she began teaching the class to help with the transition. Laura has ten years of experience teaching English as a Second Language to adults in Australia and also at camps in Thailand. She does not have any experience with teaching children or with teaching science. Her only experience with science was in high school where she had a class in physics and another in chemistry. She reported that she did not like the classes at all and found them very boring and abstract.

The circuits, conductors, and insulators activity was completed by Laura with seven students between five and ten years old. Prior to engaging with the activities in the professional development workshop, Laura reported in her pre-activity questionnaire that she was feeling “worried about my lack of scientific awareness.” The professional development session was conducted one-on-one as it was done previously with Sarah. During the reflection part of the professional development session, Laura wrote in her pre-planning journal about how she was feeling about teaching this activity and how she was planning to teach it to the students. She stated that, “I am not sure how electricity works and want to know how to explain it in case I get asked. I will Google it.” Her plan was bulleted with not much detail:

- Give out battery and light and have them turn it on
- Tape and label the circuit “light,” “battery,” “wire”
- Try out the materials and see what items turn the light “on” or “off”

- Ask if they are metals or are not metals

Laura began the lesson by turning the lights on and off repeating the words “on” and “off.” Next, she handed each student a light and battery saying, “Can you help me turn this light on?” Students worked on switching around on the wires on the lights. Some students put both the wires on the positive side of the battery. Another student put both ends of the wires on the negative side of the battery. One student put wire on either side of the battery and the light turned on. Immediately, all of the other students saw what this student had done and attempted the same on their own. However, for some children, the light did not turn on. The children then noticed and discussed in their native language that the orientation of the black wire on the negative side of the battery and the red wire on the positive side. Soon, all the lights at the table were on. The smiling children excitedly waved their light. Laura praised them for doing such a wonderful job solving the problem and told them that she was going to give them a harder problem to solve. She told the students they had to figure out which object she could put between the battery and the wire that could turn the light on. They had to first make their “special tester.” She showed the students how to tape the light, wire, and battery down. The students were able to do this, and the older students helped the younger ones with the taping. Laura drew a circuit on the board and labeled the light, wire, and battery. The students labeled the parts on the cardboard. The older students wrote the words in Farsi and Arabic under the English word. They were asked by Laura to write them on the board. They went to the board and wrote it on the board so that the younger children could copy it as well.

Next, she had the students write the word “yes” on one side of a piece of paper and “no” on the other. As she held up each of the test items she had the students hold up their sign if they thought it would turn the light on or not. Laura sorted two piles based on their guesses. Then, she gave each student a set of test materials and gave them a few minutes to test each object and sort their own piles. Students shared what they found. There was some discussion about two of the test objects where some students sorted it into the no pile and others sorted it into the yes pile. These items were the pipe cleaner and the plastic-covered paper clip. The older children explained that it worked when you put the exposed metal from the paper clip and pipe cleaner on the battery and the wire on the other side of the object. Laura went through each of the objects and the kids identified if it was metal or not. Laura introduced the words “wood” and “plastic” when discussing that the objects were made of. Laura asked the students to identify other objects in the room that would turn the light on. One student used a pair of scissors. Another student saw the outlet and asked about “electrical shock.” Laura told them to not put anything in the sockets. She also explained that the battery is different than the socket. One of the students then said “water” and tried to test it with putting water on the battery but they ran out of time.

In her post-activity journal, Laura reflected on her teaching of the circuit, insulator, and conductor activity saying, “It was excellent fun and learning. Some drop-in students came halfway through, but luckily there was lots of extra stuff and plenty of helpers, and they managed it perfectly. The small kids did perfectly well.” Laura went on to report in an interview, “I was surprised, some students had already gotten the idea about metal and one said ‘and water.’ Very interested in the testing-again, so that was fun and they were keen to take the circuits home.” She also reflected that she wished that she had covered the dangers of electricity saying:

> I did realize that we hadn't covered the dangers of electricity when one student asked for the word for 'electric shock.' So, we did talk about how this battery is different from the electric socket on the wall. Which they all knew not to play with.

In the interview she reported that she was happy that she had googled how electricity worked because she was worried about being asked by a student, which she was. After teaching all the activities, Laura reflected in the post activities questionnaire that she noticed that "They were very absorbed (more so than in English class) and enthusiastic." Laura reflected on her own practice by saying in her post-activities questionnaire, "I was worried about my lack of science background but it was an exciting and fun time. It was great watching them learn with the experiments." She also shared, "I had been a helper for a few days with Sarah and had an introduction from Erika, so that made me feel more prepared."

Prior to teaching the activities, Laura wrote in the pre-activity questionnaire that she thought science would be beneficial to her students because "I love the practical element, love the way it introduces experiments and recording." After teaching the activities, she wrote in her post-activity questionnaire that science is "fabulous! They were so interested and I love the practical element." When reflecting on her experience as a volunteer educator at the community center Laura said in the final interview, "I would love to see the kids/teens in separate classes from adults, doing more practical learning for ESL, but there isn't space/time."

Kate at the Navy Facilities School

In the suburbs of a large urban space is a quiet camp. Similar to other camps, we checked our IDs with the military personnel at the gate. At this time, there are 1500 refugees living there with the capacity for 500 more. Families live in a double room container with a bathroom, air-conditioning, and hot water that is heated using solar energy. The ground outside is cement and is often flooded due to heavy rain. There is also a smell of mold and sewage in certain areas.

Kate described the area that the camp was located and that it “used to be a beautiful place, where people went swimming in the summer before the 60s. The sunset is still magical there and many residents of the camp hold coffee shops with an amazing view. Yet the shipyards and the oil factories have turned the region industrial.” She also discussed that “before May, anyone could enter the camp since there was no ID control in the entrance. One day, the police shut down the camp and performed checks in every container, removing people without ID and arresting people without papers. Since that time, new IDs were issued and there was always control in the entrance.” The school was located in the far southwest edge of the camp, right next to the Navy’s facilities. The containers hosting the classes were two containers that had been merged. There were bars on the windows and the classrooms were air-conditioned.

Kate was a 35-year-old Greek teacher. She had been teaching science, mathematics, and STEM through educational programs at local museums for seven years. She had also been working with refugees and Roma children for the last three years in community centers and in different camps. Kate explained she was not satisfied with the science lessons throughout school. She elaborated and stated science lessons seemed distant, hard, and boring. She had a Master’s Degree in Biology Education from a university in Greece.

Each student in Kate's classroom had a desk and chairs and the classroom was set up in a u-shape. Kate explained that:

> Many of the students left for other countries with their families and new families were introduced to the camp coming from the islands. Some children were obviously traumatized and it took a lot of effort to introduce them to our classes.

This would be her second week working with some of these new students. The kids in the class were between six and eleven years old. They were grouped together because they were more advanced English speakers that were also learning Greek. Also, resources in the classroom were quite scarce since many NGOs were no longer supporting education at this particular camp. In addition, Kate shared that the NGO she was working with would stop their services at the end of the month.

Before leading the activity, Kate stated that she would "love it!" when asked in the pre-activity questionnaire about how she felt teaching science. She wrote in her pre-activity planning journal about how she would plan to teach the circuit, insulator, and conductor activity. She shared that she planned to introduce the vocabulary which included "socket," "cable," "electricity," "lamp," and "battery." She was then going to present the students with a challenge which was to provide them with the light and the battery and have them turn on the light. After the students turned the light on, she was going to introduce the word and concept for "circuit." She planned to write down each of the materials and sketch them. One of the concerns she expressed was the language barrier. Another concern was that she believed it would be "too easy for the older children and too hard for the younger students." She was also worried about the younger students eating the batteries. Something that she was excited about was "watching them turn on the lamp" and "the fact that they get to keep the whole circuit."

Kate began the circuits, conductors, and insulators activity by showing different devices in the classroom. Students pointed to the light, the radio, and the air conditioner. One of the students held up their phone as an example of a device. She asked them how their phone stays on. The students responded that they charge the battery. Kate then asked how they charged it. The students pointed to the socket on the wall. She asked the students "What does the socket give us?" One of the older students responded with the word "electricity" and another said "light." She then asked the students "What other devices do you know that work with electricity?" The students mentioned some of the household items that they have in their containers. Kate wrote the words and sketched pictures of "socket," "cable," "electricity," "lamp," and "battery." She had the students write the words and sketch their own pictures to go along with the words. Students were also asked to sketch a device that uses electricity. Kate then discussed with students about electricity and being safe saying, "We never ever play with sockets and we never put anything in the socket unless our parents tell us to plug in a safe device. If we put something in the socket we might die. We also never ever put batteries in our mouth."

She then explained that cables have copper inside and plastic outside. She also discussed that batteries have a plus and a minus end. She told the students that she had a challenge for them. She told them that they needed to turn the light on. After three minutes, all of the students had their lights on. She then introduced the concept "circuit". She said that "in Greek the word for circuit is κύκλωμα very similar to κύκλος (circle)" which she explained they had learned the previous week. Kate then repeated the phrases "closing the circuit/opening the circuit" while attaching/removing cables from the battery. She gave them another challenge where they were asked to find what materials they could put in between the battery and wire to close the circuit and turn on the light. Students tested and sorted the materials into two groups. She then brought it back to the discussion of the cables having copper inside and plastic outside. She asked the students why they thought this was. Students responded that the plastic does not let electricity pass through. Another student said that the copper would turn the light on.

Kate reflected on teaching the activity and wrote in her post-activity journal, "it went unexpectedly well." She also repeated this in a later interview saying, "The whole lesson went on perfectly, it worked really well. The students were writing in their notebooks." She went on to explain what made this activity successful, in her post activity journal she stated:

> Older children's experience and knowledge helped build strong arguments for everyone in the class. All students' participation was very encouraging; overall the subject is really intriguing in the first place. It gives the chance for everyone to narrate their stories and experiences on electricity. This group was really well synchronized to begin with and the material did not require much interpretation.

In the post-activities questionnaire Kate wrote again about student experiences saying, "I think the electricity lesson was very successful because there were so many things to correlate from the everyday knowledge that everyone has." In an interview when asked about what changes she would make to this activity Kate said:

> Next time, I would have cards with the concepts and stick them in the class on the devices, cables, lamps, so everyone can see them during the class. Plus, I would cut open an old cable to let students see that there are two smaller cables inside, red and black. All LEDs used for the younger children should have red and black cables (which they did for this kit-thank you).

One of the concerns that Kate shared was that she was worried about the language barrier. She said that the "older students interpreting into their native language was really helpful." She was also concerned about the activity being too easy for the older children and too hard for the younger, but she found the “older students were very engaged and helped the younger ones.” Her last concern was that the children may eat the batteries but stated that, “there was no problem-the younger ones accepted the fact.” In response to what she stated in the pre-activity questionnaire when she said she was excited about the students “turning on the lamp plus the fact that they get to keep the whole circuit and the lamp” after the activity she responded, “everybody loved the lamp.”

After teaching all the activities in the two units, Kate reflected on what she noticed. She stated in the post-activities questionnaire:

> I noticed that these activities helped in terms of group dynamics. I realized that some kids are more competitive than others. Other kids who are quieter were quite interested and very engaged in the activities. They were usually in the background of the class. Because it was hands-on activities, and they were very well prepared and colorful. I think that it gave the children more opportunities to show different skills that they have. Also, it gave me the opportunity to assess what I need to work on for the whole class. Because, I don’t really have materials for these children or something ready made for different languages and different levels in the class. So, these activities gave me the opportunity to assess different skills of the kids. So that was really interesting.

Kate also stated in an interview about teaching the units and students:

> It was great (laughing). I felt very happy because the kids had so many things to use. Different things than usual. We got out of the ordinary routine of our class. They were excited so I was excited too. I felt stronger and more confident because I had all of those things to give them to use.

She also stated in her post-activity questionnaire, “I think that they were happy that they could take them home. It was something they could do at home as an experiment.” Kate also reflected on herself as a teacher stating that in the electricity lesson, she “was a very good teacher” because she “knew the concepts and it was easy for the kids to understand because it was something in our daily lives everywhere.” Kate felt quite prepared for most of the activities, especially magnetism and electricity, because it was more known to her. However, she stated, “I didn’t feel as prepared for the physics activity because of the scientific background.”

Prior to teaching the activities, Kate wrote in the pre-activity questionnaire that she thought science would be beneficial to her students because “science is essential! Our students have lost too much lesson time and they need to keep up in science and mathematics in order to adjust to the new school environment.” After teaching the activities, she wrote in the post-activity questionnaire:

> I think it is very beneficial because the kids, even though they are in the intermediate stage of going somewhere else: another school, another country, another language. Science is deserved and is not everywhere in these environments. Subjects such as electricity, magnetism, and velocity and all of the stuff that can be taught with such activities are really useful anywhere they go.

In the final interview Kate discussed how important it was for the students to have fun while learning and the additional benefits of having the activities as part of the class time. She believed that aside from teaching science, the activity supported kindness and teamwork. She spoke about the value of science for her students. She stated, “in general science is a subject that can make people dream about things. It’s not pure learning about the hard stuff. You get to experiments and this is something that kids already do during their daily life in their play.” She also stated that science supports interdisciplinary learning and that “we should use science in order to learn mathematics.” This is because it provides a practical application for some of the concepts taught in the math class. Because “mathematics on its own can be really intimidating for children.”

Summary of Participants’ Experiences and TCSR Framework

The Teacher-Centered Systematic Reform (TCSR) model was used as the theoretical framework and lens for this study. In this section, I summarize and synthesize each of the participants using this framework. The relationships between their backgrounds and personal factors, their beliefs and attitudes, the teaching context and their practice is further analyzed in the findings section in order to answer the sub questions for the central research question.

Anna

Anna's background in teaching included six-months of experience teaching in a Montessori school and twelve months of experience teaching English to adults at a private language school in Australia. As a student, she had negative experiences with science that she often discussed. Prior to participating in this study, she had no previous experience with teaching science but was excited to bring it to her students. She had been at the camp teaching English classes twice a day for last two months.

The context that Anna worked in was a military-run refugee camp located in a former orphanage. She taught two English classes a day, each for one hour. The first class was a beginner class for children between seven and twelve years old. She completed all of the activities but the findings focus on her teaching of the Car and Ramp activity.

Anna's beliefs about herself prior to teaching the activity is that she felt that she did not have the conceptual understanding necessary to teach. However, her concerns about the lesson stemmed from her beliefs about the students. She believed that they were capable but also prone to violence. Her beliefs around teaching centered on this in that she planned around her concerns about the students. Therefore, she planned her lesson to be structured and teacher-led in a step-by-step manner.

Sarah

Sarah's background in teaching included extensive experience teaching science within a formal context as a teacher and as a non-formal educator running science clubs in Ireland. She also had experience teaching refugees prior to participating in the study. Sarah reported that her own experiences in school were fun, engaging, and hands-on. She also had a BS in Applied Physics.

The context that Sarah worked in was a community center. She taught English classes every day. Because of the nature of the community center, she was unsure of who would come to the class. Sarah completed all of the activities in the Physics Unit but the findings focuses on her teaching of the Car and Ramp activity.

Prior to teaching the activities Sarah expressed that she was feeling nervous and excited. Her concerns were mostly related to the context and not knowing who would come. She also believed that students would have difficulty understanding her and that they may misbehave. Her beliefs about teaching and inquiry was very open and to let them figure it out and not reveal the answer. She also was going to have students experiment independently.

Laura

Laura's background in teaching included ten years of experience teaching English as a Second Language to adults in Australia and also at camps in Thailand. She did not have any experience with teaching children or with teaching science. She did not have any experience with teaching children or with teaching science. Her only experience with science was in high school and stated that she found them very boring.

The context that Laura worked in was the same community center as Sarah. She taught two English classes a day, each for one hour. The first class was a beginner class for children between seven and twelve years old. She observed Sarah teach all of the Physics unit but the findings for Laura focuses on her teaching of the Circuits, Conductors, and Insulators activity. Laura taught the activity to seven students between five and ten years old.

Prior to teaching, Laura stated that she was feeling worried about her lack of content knowledge. Her worries about her lack of science knowledge manifested itself throughout her planning. Laura did not provide much detail but planned for a very structured lesson.

Kate

Kate's background in teaching involved teaching science to refugees for three years. She explained that her experience with science in school was boring and was dissatisfied. She had a Master's Degree in Biology Education.

The context where Kate taught was a military-controlled refugee camp. She taught English, Math, and Greek classes to children between six and eleven years old. At the time of the study she had some new students in her class.

Kate shared that she was feeling confident in her knowledge about Magnetism and Electricity but not Physics. She planned to teach the activity by presenting the students with problems to solve along the way. Her beliefs about student was that the activity would be too easy for the older children and too hard for the younger students. She was also worried about the safety of the activity.

Finding One: Language and Volunteer Educator Background

Throughout each volunteer educators' experience, they planned and taught using a variety of vocabulary words they wanted the children to learn in science. The four teachers presented here looks at volunteer educator background and the academic language they decided to teach (Table 4.1).

Both Anna and Sarah taught the car and ramp activity and modeled the words long and short with their hands while introducing the words. Anna, a person who has no experience teaching science taught weight instead of mass by "heavy" and "light." In addition, she mentioned that she would not actually introduce the word "mass" to the students. Sarah, an experienced science educator, demonstrated the correct definition of mass by showing the students two examples of mass. Furthermore, Sarah used more academic language during her teaching. These words included "science," "experiment," "hypothesis," "investigate," "mass," "force," "scientist," "facts," and "data." Both Anna and Sarah taught the words and their meanings using physical demonstrations.

Laura and Kate both taught the circuit, magnetism, and electricity lesson. Laura, a teacher with no experience teaching science or children, taught the students the words "light," "battery," "wire," "on," "off," "electricity," "metals," "not metals," "yes," "no," "wood," and "plastic." Kate, an experienced science educator, also used the words "electricity," "lamp," "battery," "wire," and "plastic" In addition to these words, Kate also taught the words and phrases "socket," "cable," "circuit (κύκλωμα)," "circle (κύκλος)," "copper," "plastic," "positive," "negative," "closing the circuit," and "opening the circuit."

Table 4.1

Summary of Finding One: Language and Volunteer Educator Backgrounds

Name	Activity Reported on	Teaching Background	Concepts/Terms Taught
Anna	Car and Ramp	• Montessori trained educator • Teaches English to new language learners • No experience teaching science	Long, short, heavy, light, force (without using the word)
Sarah	Car and Ramp	• Experienced teacher who has taught science to fourth grade for six years • Runs science clubs at her school in Ireland • BS in Applied Physics	science, experiment, hypothesis investigate, shorter, longer, mass, force, garage, scientist, facts, data
Laura	Circuits, Conductors, and Insulators	• Ten years of experience teaching English as a Second Language to adults • No experience teaching children • No experience teaching science	light, battery, wire, on, off, electricity, metals, not metals, yes, no, wood, plastic
Kate	Circuits, Conductors, and Insulators	• Taught STEM as a museum educator seven years • Has been teaching science, mathematics, English, and Greek to refugees and Roma children for three years • MS in Biology Education	socket, cable, electricity, lamp, battery, wire, circuit (κύκλωμα), circle (κύκλος), copper, plastic, positive, negative, closing the circuit, opening the circuit

The students in Sarah's group were between the ages of five to nine years old, and Laura's students were between five and ten years old. Anna's group was between seven and twelve years old, and Kate's group was between six and eleven years old. Since the teachers have groups of students that were similar in age, it can be seen that Anna and Laura, educators with no experience teaching science, taught words that were often used in everyday conversation. The goal of these teachers was to teach English through science. In contrast, Sarah and Kate used more scientific terms to teach the children. The goal for these teachers was to teach scientific vocabulary through science.

Finding Two: Beliefs about Students after Teaching through Scientific Practice

The volunteer teachers had beliefs and expectations for students prior to teaching. This was often seen in the planning phase in how they decided to teach the activities and concerns they shared. Finding two looks at teacher beliefs and concerns the teacher had prior to teaching and noticings that they had about the students after teaching the science activities and units.

The setting and context in this study played a role in teacher beliefs about students. In the camp setting, the volunteer educators had more opportunities to get to know their students' culture, interests, background knowledge and skills. In the community center where Sarah and Laura volunteered, there was always uncertainty around which students would be attending the class because it was in more of a drop-in format. All four volunteer educators mentioned that the students were very focused and excited when doing the activity.

Laura and Sarah were both teachers at the community center. Although Laura did not state any concerns, she did mention that the students were very interested and focused. She went on to mention that they were absorbed even more than in English class. Sarah did have concerns about the students' background knowledge and who would be coming to the class. This aligns with the uncertain context that happens with drop-in programs in community centers.

Teachers Anna and Kate taught in two different refugee camps. Anna was most concerned about student behavior. She even indicated that the root of the behavior stemmed from a lack of structure and also boredom and resulted in violence. However, she indicated that she thought they would enjoy the activity. Kate was concerned because there were some changes in her classroom and that there were new students who joined. She was also concerned about the language barrier since she had students who spoke three different languages.

Both teachers mentioned that they were able to see some changes in their students after they completed all of the units. Anna mentioned that she was surprised that the kids experimented independently and that they did not fight. She believes that this can be attributed to the engagement and focus that the students had when engaging in the activities. She knew that her students were bored and that they needed to be engaged and inspired. For individual students she stated that how a student, who is normally not engaged, was very focused and she was able to learn about how smart he was through the activity. Similarly, Kate was also able to assess students in her class while they were completing the activities. She was also able to see that the students were more competitive but also that they were able to collaborate across ages, cultures, and gender.

Volunteer educator beliefs about students can be seen as context dependent. As Table 4.2 shows, the volunteer educators in the camps, Anna and Kate, discussed planning for their students to support the learning goals in their classrooms. Laura and Sarah who were at the community center did not have the same opportunity to get to know the children because of the voluntary nature of the community center. After the lessons, Anna and Kate discussed what they noticed about individual students while they engaged in the activity. The data shows that all the volunteers discussed how focused and excited the children were while doing the activity.

Table 4.2

Finding Two: Beliefs about Students after Teaching through Scientific Practice

Participant	Setting	Before Teaching	After Teaching
Anna	Camp	• Believed kids will enjoy the activity • Kids will excel • Kids lack structure • Kids are bored • Boredom leads to violence • Kids will fight over cars	• Surprised that the kids experimented independently • Surprised that kids did not fight • Amazed that the students problem solved to improve the activity set-up • Students were more well behaved than normal • Surprised at how focused and smart a certain child was
Sarah	Community Center	• Concerns about students' prior experience and background knowledge around science	• Kids were excited • Noticed that the children wanted to independently develop the experiment
Laura	Community Center	• Did not list any concerns about students but rather concerns about her own content knowledge	• Mentioned how focused and interested the students were • Surprised at the knowledge some of the students had • Mentioned kids wanted to take home the activities
Kate	Camp	• Concerned because new students were just brought into the class • Language barrier • Activity being too easy for the older students and too hard for the younger • Concerned about safety	• Surprised at how interested and engaged students were • Noticed that some kids are more competitive than others • Students who were normally quiet were engaged • Mentioned at how well students worked together and collaborated (age, culture, and gender) • Kids will love science if they experiment

Finding Three: Materials and Supports for Volunteer Educators Teaching Science

It is important to understand what resources the volunteer educators need in order for them to successfully teach the activities and what helped them feel prepared to teach (Table 4.3).

Table 4.3

Finding Three: Materials and Supports for Volunteer Educators Teaching Science

Name	Supports Mentioned
Anna	• Materials and kits • Actually, doing the lessons (training) made it more straightforward
Sarah	• Pre-organized tools and resources
Laura	• Enough materials • Working with Erika and Sarah • Google
Kate	• Curriculum that supports students' backgrounds and experiences • Curriculum that supports different languages • Prepared materials

Anna believed that having the materials and kits would be good for other classes. She also mentions that the kits and training materials were set-up in a manner that was simple and straightforward. Sarah stated that the resources and having everything pre-organized was important. Laura said that having enough resources was important and also support from other teachers. Therefore, having the kits was very important for supporting her instruction. In addition to the professional development session that Laura had with me she also felt supported by being able to work with Sarah prior to teaching activities herself. Kate really looked at the curriculum and how it supported her teaching of science to her particular group of students. She mentioned that the curriculum was supportive of experiences that students had and that they could easily make connections to. She also mentions that the curriculum is able to support teaching students who speak other languages. similar to Anna, Sarah, and Laura, Kate found the materials being preorganized to be supportive of her instruction.

The volunteer educators all discussed the importance of having the material in order to teach the activities. Also, Kate stated that the curriculum was flexible enough to meet the needs of the students in her classroom. Lastly, both volunteer educators with no science background, Anna and Laura, found the professional development to be helpful and necessary.

Finding Four: Volunteer Educators' Beliefs in Themselves

Beliefs and attitudes towards one's ability to teach are often connected to educator background and past experiences that the volunteer educators have had. Teacher background and content knowledge was a theme that was present throughout the study for some of the volunteer educators.

Prior to teaching the activities, the teachers without science backgrounds, Anna and Laura, acknowledged that their lack of content knowledge was a concern for them. Kate, a STEM educator, also mentioned that she was much more knowledgeable about the concepts in the magnetism and electricity unit than the physics unit. This demonstrates that their background with science or even certain disciplinary core ideas can influence their beliefs towards themselves and their teaching.

All of the participants expressed that they were feeling more confident at the end of the activities (Table 4.4). There are many factors that may have contributed to this perceived success. Anna saw the activities as doable within the context that she was teaching with the materials that were provided to her. Sarah and Kate discussed their students and how they were excited by their students being excited. Kate also mentioned the context in relation to having the materials and being out of the routine. Laura, who was not confident in her background knowledge, sought out Sarah as a role model prior to her teaching the activities in order to develop her skills.

Table 4.4

Summary of Finding Four: Volunteer Educators' Beliefs in Themselves

Name	Activity Reported on	Before Teaching	After Teaching
Anna	Car and Ramp	• Concerns were related to lack of content knowledge • Concerns related to the context (behavior management)	• Felt that it was much more straightforward and self-explanatory than she realized • Was more comfortable and excited than she predicted
Sarah	Car and Ramp	• Concerns were related to the context (management, number of students, background knowledge of students) • Expressed that she was nervous but also excited	• After teaching the lessons she expressed that she felt, "great" • Expressed that she was excited to watch the children experiment
Laura	Circuits, Conductors, and Insulators	• Concerns were related to lack of content knowledge	• Concerned throughout about her lack of content knowledge • excited that the children were learning • felt more prepared because of working with Sarah (teaching) and Erika (training)
Kate	Circuits, Conductors, and Insulators	• Expressed confidence in relation to the activity • Concerned about her content knowledge for the physics unit	• They were excited so I was excited too • Felt stronger and more confident because she had

			materials to give them to use • Believed that it went unexpectedly well • Said she enjoyed the activities because it was out of the routine

The data show that three of the educators discussed their lack of background knowledge as a concern. However, it was not shown to be a barrier to teaching the activities. After teaching the activity, the volunteer educators expressed increased confidence. Furthermore, the educators discuss the excitement of their students. This physiological response from the students transferred to the volunteer educators and resulted in increased confidence.

Finding Five: Value of Science for Refugee Learners

This finding looks at the perceived value of science for refugee learners made by each of the volunteer educators. These cases were analyzed to identify any comments that the participants made before and after the teaching of science to refugee learners. Each participant described similar but also different values of science for their students. All four participants discussed how excited and focused the children were to do the activities and how it is important for children to learn through practical hands-on activities (Table 4.5).

Table 4.5

Summary of Finding Five: Value of Science for Refugee Learners

Participant	After Teaching
Anna	• Inspires • Motivates • Hands-on • Provides Excitement • Students were better behaved and focused
Sarah	• Provides Excitement • Hands-on • Provides opportunity for students to investigate
Laura	• It is practical • Provides Excitement/Enthusiasm • Students were focused/absorbed • Interdisciplinary (ENL/ESL)
Kate	• Science is essential and deserved • Provides excitement • Hands-on • Supports collaboration, kindness, and teamwork • Interdisciplinary: Can be used to teach mathematics

The data show that Anna believed that science is something that inspires the children and motivates them to learn. Also, according to Anna, it provides for a safer classroom environment where there were no incidences of violence in the classroom for the whole time the activities were being taught. She attributes this to the students being focused and actively learning through the hands-on activities and therefore not being bored. Both Laura and Kate mention that science can be used to teach other subject areas that may be viewed by the children as boring such as ESL or Mathematics.

Finding Six: Volunteer Educator Background and Practice

This finding examines volunteer educator's backgrounds and beliefs about students impact how they teach science. Some of the volunteer educators had a more structured approach to inquiry whereas others were more open to students investigating on their own (Table 4.6). For example, Anna started with a very structured inquiry when distributing the materials and setting up the data table. However, as the lesson progressed she had students investigate independently through free play. Laura also allowed for more open inquiry in how she led her instruction. She used the students' knowledge and experiences to teach the lesson. She also used challenge questions to engage the students in problem solving. Sarah taught slightly differently than she had planned. I noticed that although Sarah often stated that children need to learn through play (open inquiry), she taught using structured inquiry and suggested that others do so as well. For example, while teaching, she began with giving the students the question they would answer, listed out the materials, had the students "hypothesize," had them create a chart to graph their data (results), and go back to answer the question. Kate also connected the learning to the students' backgrounds and experiences and used a lot of sketches to teach vocabulary. Similar to Laura, she asked the students challenge questions. Kate's lesson was less structured than Laura's but still had the students answer her questions.

Table 4.6

Summary of Finding Six: Volunteer Educator Background and Practice

Name	Activity	Teaching Background	Observations of Teacher Practice
Anna	Car and Ramp	• Montessori trained educator • Teaches English to new language learners • No experience teaching science	• Taught vocabulary through physical demonstrations • One by one so that students could complete the set-up step-by-step • Students worked in groups • Smiled and had kids investigate on their own • No closure or review of data to make predictions for a fourth washer
Sarah	Car and Ramp	• Experienced teacher who has taught science to fourth grade for six years • Runs science clubs at her school in Ireland • BS in Applied Physics	• Asked children if they know what "science" is • Had children clap out the words: experiment, mass, and force" • Defined for the children the words "Mass" and "Force" • Demonstrated with her hands "short" and "long" for distance • During the activity stated that "scientist need to be consistent" • Had the students complete the set-up on their own after modeling it fully • Students worked independently •Asked students at the end what scientific fact they learned that day
Laura	Circuits, Conductors, and Insulators	• Ten years of experience teaching English as a Second Language to adults • No experience teaching children • No experience teaching science	• Turned on and off lights to introduce words, "on" and "off" • Had students figure out how to put the wires on the battery • When students had discrepancies in their results they were able to discuss and demonstrate why they were correct (pipe cleaner & paperclip) • Had them identify other things in the classroom that would turn on lights • Was going to have them investigate their question about water but ran out of time
Kate	Circuits, Conductors, and Insulators	• Taught STEM as a museum educator seven years	• Had students identify objects around the room and discuss their own experiences with electricity

		• Has been teaching science, mathematics, English, and Greek to refugees and Roma children for three years • MS in Biology Education	• Used this knowledge to connect to vocabulary she wanted to teach • Gave students challenge questions • Discussed how electricity works (Circuit) • Students tested and sorted materials • Students share why each material was able to turn on the light or why it did not

It can be seen from the table that the volunteer educators with backgrounds in science, Sarah and Kate, taught using a more structured approach. This approach mirrors the scientific practices with more structured inquiry. The teachers who had less science background knowledge allowed the students to experiment with the materials in a more open way.

Chapter V

DISCUSSION AND CONCLUSIONS

This qualitative multi-site case study examines the experiences of four volunteers serving as educators and their use of science kits in three separate non-formal refugee spaces located in Greece. They received professional development and materials to support their teaching of science. The central research question for this study was:

- What are the experiences and perceptions of volunteer educators teaching hands-on science activities in non-formal refugee education settings?

The sub-questions were:

- What kind of preparation and materials do volunteers need to teach science in non-formal refugee education settings?
- How does hands-on professional development in science affect volunteer educators' confidence, attitudes, and beliefs towards teaching science?
- How does a background in science prepare volunteers to teach science in refugee settings?
- How does the volunteer educator view the value of science education for refugee learners in non-formal refugee spaces?

Summary of Major Findings

There has been limited research on the teaching of science in non-formal refugee spaces and the resources required to support volunteer educators. Some of the results of this study support the results found in other studies. There are additional findings that can contribute to science preparation for volunteer educators where science was being taught in non-formal refugee spaces. The major findings of the study are discussed in the sections below.

Volunteer Educators' Backgrounds

First, I found that volunteer educators that had a background in science incorporated more scientific academic language into their instruction. Also, volunteer educators with a background in teaching English to Second Language Learners used more everyday language when teaching the science activities. The volunteer educators all referred to their students' background experiences, objects in the room, models and examples, drawings, and physical demonstrations when introducing new vocabulary.

In a previous study, we had some emerging data that suggested volunteer educators did not have a background in teaching science and they expressed having little confidence to teach (Gillette & Halpern, 2018). This initial research was completed at the beginning of the refugee crisis in Greece where we found similar findings to Ficarra (2017) that there was an abundance of volunteers in the camps but most of them were not trained educators or had a background in science. As time has gone by, there have been more qualified volunteer educators leading language and mathematics classes. For this study, I was able to have two volunteer educators who had a background in science and two who did not. The other two volunteers were trained ESL/ENL teachers.

Volunteer educator background was shown to impact their choice of academic language they used while leading the activities. As suggested by Fathman and Crother (2006), the volunteer educators in this study selected a limited amount of science vocabulary for use in their instruction. Teachers who were trained in teaching English Language Learners integrated more everyday language into the activity. In contrast, teachers with a background in science used scientific academic language. This supports the instruction of science to refugees who are learning a second language in that the educator must understand the vocabulary that they will be incorporating into their instruction. In addition, they need to have some understanding of how they will introduce the new vocabulary. In this study, all the teachers were able to connect the new vocabulary to backgrounds and experiences that students had, objects in the room, models and examples, drawings, and physical demonstrations of the words and their meaning.

Three of the teachers, Anna, Sarah, and Kate suggested that they were concerned about their lack of science content knowledge; however, this did not present itself as a barrier to teaching their activities. In support of Rubino (1994), the volunteer educators without a background in science that attended the professional development workshop self-reported an increase in science content knowledge. Also, similar to the study by Nowinski, Sullivan-Watts, Shim, Young, and Pockanly (2012), all the volunteers were able to accurately present the science kit activities. The teachers with a science background were able to present the activities with the most accuracy. Similar to Nespor

(1987), the findings from this study support that the volunteer educators' teaching practice was mostly driven by their backgrounds and beliefs about students rather than their content knowledge.

Furthermore, the volunteer educators without backgrounds in science allowed for more open inquiry. Volunteers with backgrounds in science taught using more of a structured inquiry. Both groups of teachers taught using student-centered and teacher-guided instruction.

Contexts and Frequency

Second, findings show that volunteer educator's backgrounds and beliefs about students impact their instruction, in addition to the contexts in which the educators taught. I found that the ability of a volunteer educator to support their students' growth and learning is contingent on the context and the frequency that the teacher encounters the student. Within the camp context, the volunteer educators had more opportunities to connect with students each day and they were able to learn more about and assess their students' social and academic skills. The volunteer educators in the community center had less contact time with the students and the attendance was uncertain. All the volunteers observed that their students were engaged, excited, and wanted to experiment when engaging with the activities.

Kit-based Instruction

Third, the volunteer educators found the prepared kits and support materials to be beneficial to their teaching. The findings also suggest that the curriculum was supportive of integrating other disciplines such as language and mathematics. By engaging in scientific practice during the professional development session, volunteer educators with little confidence reported improved confidence to teach science.

Kit-based science has been shown to be a valuable resource for schools that are poorly equipped or isolated (Fetters et al., 2002; Rennie, Howitt, Evans, & Mayne, 2010; Young & Lee, 2005). The studies by Welzel and Breuer (2006) and Perrier and Nsengiyumva (2003) discussed the need for quality materials and volunteer educator training for supporting the teaching science in non-formal settings to children with interrupted education. In this study, all four participants expressed the importance of having the materials for the activities being well prepared. If the material is not organized and prepared, the educator can view teaching science as time-consuming and hard to manage (Edelson et al., 2019; Quintana et al., 2004; Sharples et al., 2014).

Therefore, I used the findings on kits use in low-resourced settings from Rennie, Howitt, Evans, and Mayne (2010) to support the organization and preparation of the kits and materials used for this study. I tried to ensure that they were well-organized and clearly labeled. In addition, the activities and worksheets were designed specifically for refugee children who have experienced interruptions to their education and were differentiated across skill levels. The activity guide contained science knowledge support for the teacher and there was also a video and photographic guide with instructions for the activity set-up. Thus, having the kits organized and prepared, the volunteer educators had more time to think about how they could modify the activities for their students to ensure that they were relevant and meaningful as supported by the findings by Sherman and MacDonald (2008).

Kit-based Teacher Professional Development

Related to the previous finding, this study found that prior to engaging in the professional development and activities, volunteer educators expressed some concerns about their lack of content knowledge. By the end of the activities, they expressed some increased confidence. This was mostly a result of engaging in the practiced based professional-development session with using the prepared-kits prior to teaching them with the students, having support from others in the room, and having others student engage and help other students.

In addition to the kits needing to be prepared and organized, they need to be engaging and personally relevant to the child (Aschbacher, Ing, & Tsai, 2013; Christensen, Knezek, & Tyler-Wood, 2015; Sharples et al., 2014). Although many of the volunteer educators made references throughout to student experiences during their teaching, Kate specifically mentions how she was able to use the curriculum to make connections to student experiences. As stated by Christensen, Knezek, and Tyler-Wood (2015) and Welzel and Breuer (2006), in addition to making connections to students' experiences, the activities should be teacher-guided and student-centered and not teacher-directed. Although most of the instruction was student-centered, teachers with backgrounds in science guided the students in a more structured way. This can be attributed to the understanding that teachers with science knowledge have the procedural knowledge of how to enact inquiry. Whereas, teachers without science knowledge don't know how to structure inquiry, so they choose to avoid the structure.

The volunteer educators were provided with videos, teacher guides, and professional development in addition to the kits. As stated by Rubino (1994), the use of kits is most effective when professional development is provided to the educator. In support of Forbes (2011) and Solomon and Tresman (1999), this study also found that providing the volunteer educators the opportunity to engage in scientific practice on their own allowed them the opportunity to reflect on their own teaching and learning in science. In addition, the professional development session allowed the volunteer educators the opportunity to integrate some of the goals they are working on in their classrooms. Also, after engaging in using the science kits during the professional development session, some of the volunteer educators shared that they were feeling more confident. Laura stated that the professional development session helped her feel more prepared. Anna also stated that actually doing the activities was helpful to her. Both Anna and Laura had expressed concerns about their content knowledge prior to the professional development session. This finding with volunteer educators is supported by Rubino (1994) and Sherman and MacDonald (2008) when they shared that teachers who used science kits had an increase in their content knowledge, pedagogic content knowledge, confidence, and enthusiasm for science.

The volunteer educators' preparation can be seen in the pre-activity journals that they completed prior to teaching each activity. The educators were thoughtful about how they would make the lessons relevant and meaningful for their students. As discussed this was more visible in the context of the refugee camp where the educators knew each of their students whereas the educators at the community center were unsure of who would be coming to the class.

Benefits of Science Education for Refugee Learners

Refugee children who have experienced interruptions need to learn in a way that supports their socio-emotional development. The findings show that there are many benefits of science for refugee learners as reported by the participants in this study. First, practice-based science provides an active learning opportunity where the students are excited, focused, and motivated to complete the activity. It also supports students' social behavior resulting in collaboration, kindness, and teamwork.

The benefits of science for refugees is a topic that has not been researched in the non-formal education context. However, many of the results and benefits that were reported by the volunteer educators align with existing research on the effect of practice-based science on student engagement and learning in non-formal settings. In a study conducted by Sherman and MacDonald (2008), teachers reported that students who learn using pre-constructed kits are excited about science class and often look forward to and participate in activities. In addition, this excitement to do the activities can lead to positive student attitudes towards science (Rubino, 1994; Sherman & MacDonald, 2008). This conclusion can also be applied to the context of non-formal refugee education. The volunteer educators in this study all reported that the students were focused, excited, and engaged when actively learning using these preconstructed science kits. Engaging students in scientific practice through active learning allows for science to become more concrete and experiential (Buxton & Lee, 2014).

In addition to being exciting and engaging, practiced based science supports students who may not yet have a mastery of the language in which instruction occurs and also supports language acquisition by contextualizing the language (Studdart, Solis, Tolbert, & Bravo, 2010). Academic language can sometimes be a barrier to instructing students who are learning a new language (Gomes & Mensah, 2016). However, engaging in scientific practice gives students who are acquiring a new language the opportunity to develop skills to observe, describe, explain, predict, estimate, and infer through the process of hypothesizing, explaining, predicting, and reflecting to identify different language functions (Buxton & Lee, 2014). By developing practiced based activities that allow for multiple pathways to student learning, there is flexibility in the academic language that is introduced. The educators in this study chose words that they could connect to the activity as well as student's experiences. It is important for a curriculum to be flexible in the academic language that can be used so that to support all students at different stages of language acquisition. Kate mentions that the curriculum is supportive of teaching students who speak other languages.

Lastly, engaging in scientific practice gave refugee students an opportunity to learn in a way that was different from how they were being taught in a teacher-centered way. Similar to the study completed by Theodoraki and Plakitsi (2013), volunteer educators in this study reported that the science activities supported teamwork, collaboration, active questioning, and student-centered learning.

Limitations

I have been working within the non-formal refugee context for the last four years. I have been able to see how a new crisis becomes a protracted crisis over time and the impact that it has on the quality of volunteers, resources, and educational opportunities that are available.

The use of kits and resources has been used by UNICEF to teach children. This program, School-in-a-Box, has been criticized as a one-size fits all way of approaching education in emergency settings (Sommers, 1999). Kits-based teaching, as evidenced from this current study, shows that there is flexibility in how teaches use materials. A limitation can be that the materials for the kits need to be replenished and should be able to be procured locally. The kits used in this study were prepared and brought from the United States to Greece. I have since been able to get all of the material locally in Greece. However if this were to be scaled up, a supply system would need to be identified. In addition, the activities that were part of this unit were designed to be flexible in order to support the goals for each learner.

I was pleasantly surprised that all of the participants had some experience with teaching. Some were trained educators that were volunteering. I was also unsure of what to do when one of the participants had to leave unexpectedly half-way through the study. This however did allow for more discussion of volunteers with and without backgrounds in science. One of the drawbacks of this event on the research is that I did not develop a strong relationship with all four participants over the ten days with each of them. This also led to my only being able to have the first and last interview with two of the participants. In addition, I only had one location for the community center context and two for the camp context, which provided different settings and interactions that I did not plan for.

It is difficult to generalize from this study with only four participants and this presents a limitation. However, four participants is good because it provides the opportunity to develop a deeper and more meaningful understanding that one may not have with more participants.

Implications and Future Research Directions

This study has implications that can impact future research and policies in the field of education and specifically science education within the refugee context. First, this study provides additional evidence that science is important and should be taught within the refugee context. From the perspective of the volunteer educators, the science kits provided many benefits and supported their engagement in future scientific learning. Also, the use of preconstructed kits is essential for the teaching of the activities to refugee learners since many NGOs and teachers in non-formal settings often do not have the finances to procure or time to prepare the materials themselves. The kits also needed to be developed in a flexible manner to accommodate refugee children who have experienced interruptions to their education in order to accommodate their instructional levels. Some of the volunteers commented on how excited the children were to take the materials home. In the future, it would be interesting to research how the children communicate their understandings with members of their communities or with their family.

Second, for the volunteer educators in this study, it was clear that their backgrounds did influence how they taught the activities within a non-formal context. Those who have a background in science or teaching science are best prepared to lead activities that engage students in structured scientific practice. The study reveals that volunteers who have a background in science should be mindful of the language that they incorporate into their instruction for refugees, making sure that it is at the instructional level and is accessible for the learners. All teachers, regardless of backgrounds, should demonstrate or draw examples of the concept to support student understanding of new vocabulary.

This study also suggests that volunteer educators benefit from professional development to support their teaching of the activities. Although the curriculum did have a section with information about the concepts, it would also be important to provide additional links and resources to online-material to support teachers understanding of the science concepts being taught. For future professional development, there should also be an introductory presentation on how to lead activities using structured practice and ways to connect it to the students' lives. Volunteer educators in emergency education may also benefit from engaging in a virtual community of practice (Mendenhall, Skinner, Collas, & French, 2018). Both Anna and Kate had made reference in their post-activity questionnaire an opportunity to share information with other teachers who were teaching the same activities. Platforms such as Whatsapp or a social media group could be provided as a platform for teachers to share their ideas, photos of students' work, and reflections with other volunteer educators.

From volunteer educator responses, they are able to effectively teach the lesson and activities regardless of volunteer educator background. It is important to note that the volunteer educators stated that students were most engaged when the science concepts were made personally relevant to the children. It is important for the volunteer educator to know the culture and experiences of their students so that they can make it culturally relevant (Mensah, 2011). In the future, I would like to focus more on how educators use their understanding of their students to make the material culturally relevant to their students.

Another direction for the future is to determine if the curriculum can be replicated and scaled to other low-resource areas. This study could be extended to use the same activities in different world contexts. It would be interesting to see if the findings can be applied within a global context. This will help to understand how educators in low-resourced areas and contexts choose to teach and what the perceived value of science is for their students within different communities. Furthermore, in this future study, I also would like to look specifically at the students and how they express their conceptual understanding of the activities in their native languages.

Conclusion

We know that the confidence and attitudes of educators towards science can transfer to their students (Bandura, 1977; Gunning & Mensah, 2011; Menon, Shelby, & Mattingly, 2016; Tschannen-Moran, Hoy, & Hoy, 1998). This research is important to demonstrate that professional development as well as preconstructed kits can support volunteer educators' confidence and attitudes towards teaching science to refugees in non-formal settings. These volunteers provided the students with some of their first experiences with science. The excitement and confidence they may have transferred to their students may incentivize them to seek out additional resources and continue to learn science.

Children around the world who come from conflict-affected areas and have experienced an interruption to their education should have the same access to science that would have been afforded to them if they had access to it in their home country or even in their host country. Since science is not taught to refugees in Greek schools, the community centers and non-formal schools in the camps are the only places where they can go to receive science education. As Lederman (2016) wrote, “We must seek out and take advantage of every opportunity to improve society through science, no matter how difficult or insurmountable the task may seem” (p. 2). It is through this work that we can promote scientific literacy for all children globally.

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APPENDICES

Appendix A

Description of Kit Activities for Physical Science Units

Force and Motion (Aligned to NGSS: PS2.A, PS2.B, PS2.C, PS3.A, PS3.B, PS.3C)
Activity 1: Car and ramp (students get a small toy car and place weights inside a cup on top and measure the distance it travels with the varying weights. Students will measure using standard or non-standard units of measurement depending on their age.)
Activity 2: Balloon Hovercraft (Students create their own Hovercraft and then test it by timing the amount of time in motion with a stopwatch and observing how it moves on different surfaces)
Activity 3: Pom Pom Catapult (Students create their own catapult and design a target. They launch pom poms at the target and add up their amounts)

Magnetism and Electricity (Aligned to NGSS: PS2.B, PS2.C, PS3.A, PS3.C, PS.3D)
Activity 1: Magnetism (students test objects to see which are attracted to the magnet)
Activity 2: Testing for Insulator and Conductors (Students build a circuit with a LED and coin cell battery, label the parts of a circuit, and test objects to see which ones are conductors or insulators)
Activity 3: LED Flower (Students create a flower that contains a LED with leads and coin cell battery. Students create a circuit and explain how energy travels and reinforces activity 2)
Activity 4: Paper Circuits (Students create a circuit with conductive copper tape, a LED, and coin cell battery. They explain how energy travels and why the copper tape works.)

Appendix B

Pre-activity Questionnaire

Name: ____

Email Address:_________________________________

Nationality: ___________________________________

Name of the community center or organization you are volunteering with:

____

Dates you are volunteering:

____

Please describe your teaching background:

____

____

____

____

Do you have any other experience working with children?

____

____

____

____

Have you worked with refugees in the past? If yes, please describe

____

____

Do you have any experience or training teaching science? If yes, please describe.

What were your experiences with science throughout school (elementary, middle/ high school/ university)? What did you learn? At what age? How did you learn it?

Do you think it is beneficial for the children you work with to be learning science? In what ways?

How do you feel about leading/ facilitating science activities?

Anything you would like to add?

Appendix C

Pre-activity Journals

Name: ____________________________

Date:_____________________________

Location: __________________________

Pre-Activity: Planning Journal

Name of Activity:

What are your plans for teaching this activity? What concerns do you have about leading the activity? What are you most excited about in teaching this activity?

Appendix D

Post-activity Journals

Name: ___________________
Date:______________________________
Location: __________________________

Post-Activity: Reflection Journal

Name of Activity:____

Please reflect on how they the activity went. What are some learnings (if any) from the activity that you gained from teaching the activity? What did you notice about students in doing the activity? How would you modify the activity in the future?

Appendix E

Observation Protocol

Name of Volunteer Educator: ____________________________________
Date: _________________________________
Activity: ______________________________
Language of Instruction: ____________________
Number of Students: __________ Number of Boys:______ Number of Girls: ______
Set-up of the classroom:

Questions asked by volunteer educator:
Academic Language used: ____
Interactions between teacher and student:
Additional observations:

Appendix F

Interview Protocol

First Interview:

1. Can you tell me about your experiences with learning science in elementary, middle, and high-school?

2. Have you ever taught science? Can you tell me about your experiences with teaching science?

3. Do you think children in your classroom should learn science? How should it be taught?

4. How are you feeling about teaching the activities?

Second Interview:

5. What planning did you do before the activities?

6. What resources did you use to plan?

7. In your pre-activity journal, you mentioned ______________what did you mean by that?

8. In your post-activity journal, you mentioned ______________what did you mean by that?

9. Did you notice anything about your students during the activities?

10. How did you feel teaching the activities?

11. When you taught the ____________activity, you said/did ____________. Why did you say/ do that?

12. Were there any challenges that you encountered during the activity? How did you overcome them?

Third interview:

13. Do you think children in your classroom should learn science? How should it be taught?

14. Which activity went well? How can it be improved?

15. Which activity was not successful? How can it be improved?

16. What planning did you do before the activities?

17. What resources did you use to plan?

18. In your pre-activity journal, you mentioned ______________what did you mean by that?

19. In your post-activity journal, you mentioned ______________what did you mean by that?

20. Did you notice anything about your students during the activities?

21. How did you feel teaching the activities?

22. When you taught the ____________activity, you said/did ____________. Why did you say/ do that?

23. Were there any challenges that you encountered during the activity? How did you overcome them?

24. Is there anything you would like to add?

Thank you!

Appendix G

Post-activity Questionnaire

<u>Post Questionnaire</u>

Name: ____

Email Address:_________________________________

Name of the community center or organization you are volunteering with:

____

In what ways did you feel prepared or unprepared for leading or assisting with science activities?

____

____

____

How did you feel about leading/ facilitating science activities this week?

____

____

____

What did you notice about the kids during the activities?

____

____

____

Which of the science activities did you find to be the most successful or effective if any? In what ways?

Which of the science activities did you find to be the least successful or effective if any? In what ways?

How beneficial do you think it is for the kids your work with to be learning science? In what ways based on your experience from the last week?

What have you learned about refugee education during your time at the camp/ community center?

Anything you would like to add?