Engaging Immigrant and Refugee Children in STEM During Out-of-School-Time Using a Multiple Research Approach

By

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ABSTRACT

Over the past decades, federal and local governments have embraced out-of-school-time as essential for a complete educational experience for school children, especially children who come from low socioeconomic backgrounds. These programs serve as supplemental academic and socioemotional resources for the students. In some cases, skills learned in these programs translate into students' academic progress. Using a multi-tiered approach, this project examined effective ways to engage immigrant and refugee children in learning during out-of-school-time. The research question and objectives were developed using a participant observation method over an 8-month period. Interventions were then tested using project-based learning, coupled with culturally relevant content. The results showed that culturally relevant content improves students' engagement in math learning. Well-structured out-of-school-time for immigrants and refugee children can help them acquire the needed skills to succeed in school.

Keywords/phrases: culturally relevant content, engagement, immigrants, refugees, out-of-school-time

CONTENTS

LIST OF ABBREVIATIONS

ACE	African Community Education
PBL	Project-based Learning
ZPD	Zone of Proximal Development
STEM	Science Technology Engineering and Math
TRT	Teaching Recovery Techniques
INSETT	In-service Teacher Training
FIRST	For Inspiration and Recognition of Science and Technology
NIOST	National Institute of Out-of-School-Time
NCAA	National Collegiate Athletic Association

Chapter 1: INTRODUCTION

Overview of refugees and immigrants in the US

Due to wars, religious persecutions, and climate disasters, the number of refugees has increased over the past decade, and that number is expected to rise as climate change related disasters worsen (Thomas, 2016). The second Groundswell report (Clement et al., 2021), for example, found that more than 200 million people will be displaced because of climate change by 2050. This may include internal as well as across region displacements. Whereas some refugees can return to their home countries, for many, that is impossible. A permanent resettlement in a different country or region is the safest and better decision for them (United Nations High Commission for Refugees (UNHCR), United Nations Development Program 2015, p.46).

Over the past decades, the US has become a top destination for refugees around the world (Lapore, 2015). Since 1980, when Congress passed the Refugees Act, the US has admitted more than 3.1 million refugees. Whereas resettlement programs for refugees abound, they are mostly aimed at assisting the parents to find employment to be self-sufficient. To support the resettlement of refugees, the US government has instituted programs such as cash assistance and affordable housing for refugee families, among many others. Services that are designed to identify developmental problems to improve the socioemotional development of refugee children are either non-existence or inadequately resourced (Park & Katsiaficas, 2019). It has been found that even if resettlement organizations provide psychological support to these immigrant and refugee children, their services are not trauma-informed (Park, Katsiaficas, & McHugh, 2018). However, half of these refugees are children below 18 years (Save the Children, 2016; United Nations, 2016).

Despite their resiliency, scholars have established that the traumatic experiences of refugee children are far-reaching and can have detrimental psychological effects (Park and Katsiaficas, 2019). Compared to native-born children, refugee children are less likely to seek psychological support. The challenges refugee children face when accessing psychological support can be financial, lack of transportation, and linguistic barriers (Hooper, Zong, Capps, & Fix, 2016). Sometimes, these families are unaware of the available services. Others are unwilling to access it due to their cultural perceptions and stigmas about mental health and seeking psychological

support. Maxwell and Kwon (2016), for example, found that Asian Americans are three time less likely to seek mental health services compared to white people. Similarly, Latinos and African Americans are less likely to receive mental health services (McGuire & Miranda, 2008). Among the major reasons for the difference is the perception about mental health, especially, those influenced by culture.

Like the growing refugee population, the US is home to more immigrants than any country in the world (Budiman, 2020). There are currently about 45 million foreign-born in the US. About a million immigrants arrive in the US every year. Worcester, for example, is a Sanctuary City. Around the turn of the 20th century, a wave of Armenians, Swedes, and Finns arrived in Worcester. In the late 20th century, Latin America and the Caribbean immigrants made Worcester their home. Nigerians, Ghanaians, Liberians, and Somalians are the recent arrivals in Worcester. The Ghanaian immigrant population, for example, constitutes 10% of all foreign-born (Goodman et al., 2015). As an industrial city, Worcester was a quintessential American city where people who arrived penniless and with less English fluency could rise to the middle class (Davidson, 2016).

Although not on the same level, most immigrants are like refugees in many ways. They both experience the pre-immigration, immigration, resettlement, and new living experiences (Pierce & Gibbons, 2012). Some immigrants have moved to the US for economic opportunities. Some might not be native English speakers even if they have advanced education to improve their economic prospects. In most cases, the home culture of immigrants is almost certainly different from the US dominant culture. All these put immigrants at a disadvantage compared to native born Americans. As a result, immigrant school children go through their version of cultural shock compared to that of refugee children. Their poor economic situation, different cultural experience in their home country, and the stress of settling in a new environment puts immigrant children also at an academic disadvantage that requires tailored accommodation for their transition.

Over the past decades, several studies have explored the lives of immigrant and refugee children, with emphasis on their integration into the larger society (Lunneblad, 2017; Nakeyar et al., 2018; Phillimore, 2011) and to ameliorate their traumatic experiences associated with moving from a known environment to the new (Crowley, 2009; Fazel et al., 2009). Most refugee children are at critical developmental stages. The impact of their past adversities on their

psychological development can be long-lasting. Some of these children have moved from one refugee camp to another, and as a result, have had spotty educational experiences (Krafft et al., 2018). This makes the school a uniquely important institution, not only for educating these displaced children, but also as an important vehicle for resettlement, proper integration, and intentional inclusion (Lepore, 2015; Thomas, 2016). Some have therefore proposed school-based counseling services to meet the mental health needs of refugee children (Fazel et al., 2009).

Students spend a considerable amount of their time in schools. The schools already have resources and the amount of time spent at school makes it the ideal place to support children with traumatic past. However, not every school intervention is effective. For a successful intervention, such programs must not only target the children but their teachers as well to make them trauma-informed so that they can provide the needed support (Durbeej et al., 2021). Similarly, these interventions must consider the lives of these children after school hours and must include their parents (guardians) into these services (Fazel et al., 2009). Teaching Recovery Techniques (TRT) and In-service Teacher Training (INSETT) is an example of a holistic school-based intervention. TRT is aimed at equipping refugee children and adolescence with the cognitive skills needed to navigate their traumatic past; INSETT is designed to equip teachers of these refugee children to help them become trauma-informed educators (Durbeej et al., 2021).

Sport has been identified as one of the most effective tools for refugee youth resettlement, inclusion, effective integration, and academic progress (Capalbo, 2019; Rich et al, 2015). Whereas participatory sport can be many things for different communities, when well-managed, sport participation can be instrumental in building social cohesion and capital. Participatory sport can promote friendship, build social contracts for a robust citizenship, and promote inclusion and trust for different communities (Misener & Mason, 2006). Further, participating in sport can provide refugee children some of the opportunities they need for optimal growth and developing (MacMillan et al., 2015). Soccer, for example, is seen as a universal sport and most refugees are both familiar and interested in it (Kittelmann, Korp, & Lindgren, 2017).

Aside from the school-based interventions, amount of time students spend outside school, and the growing demand for out of school time for school children has also made afterschool programs important avenues for supporting immigrant and refugee children. This is further supported by the possibility to tailor resources for these children (Hall et al., 2015). A well-structured afterschool program does not only improve the academic performance of children who

attend, it also plays a critical role in the development and health of the children (Lauer et al., 2006). More than 7 million children attend after school programs and parents continue to patronize it because most parents agree and research support (Gottfredson et al., 2010) that children who attend afterschool programs are less likely to get into trouble, kept safe, and receive adequate adult supervision. This positive parental view of afterschool programs increased from 66% in 2014 to 74% in 2020 (Afterschool Alliance). Through mentorship, games (including structured and unstructured), and scheduled time, students who participate in afterschool programs exhibit positive behaviors and are less likely to demonstrate problem behaviors (Durlak et al., 2010).

Immigrant and refugee children have varying learning needs. Coupled with their educational demands, immigrant children experience a lot of stress in their transitioning. For refugee children, their traumatic experiences, and sometimes irregular educational experiences, from living in refugee camps, impede their development and learning. Despite the key role schools play in the transitioning of immigrants and the provision of psychological needs for refugee children, resources at school are inadequate. The afterschool time of these children therefore becomes an integral part of the development and education of immigrants and refugee children. The African Community Education (ACE) in Worcester has over the past 15 years demonstrated the importance of a well-structured afterschool program in the lives of recently arrived immigrants and refugee children.

The African Community Education, a resettlement organization in Worcester, has provided after school educational, cultural, and social resources for immigrants and refugee families from West, East, and Central Africa—as well as South Sudan—since 2006. It serves over 60 children (from 5^{th} to 12^{th} grade) every year. These students have diverse cultural heritages, experiences, and learning needs. This program recognizes and incorporates their cultural background into academic enrichment activities. The approach is aimed at improving their academic achievements using out of school time, an effective medium for improving learning for *disadvantaged* students (McDaniel & Yarbrough, 2016).

Statement of purpose

A student's academic success and future employability largely depends on their performance in science and math (Brown et al., 2016; Duncan et al., 2007; Romano et al., 2010). Racial and ethnic minorities are less likely to major in STEM and are underrepresented in STEM careers (Brown et al., 2016). Lack of persistence and preparedness, especially in high school math are the few identified causal factors for the underrepresentation of minorities in STEM (Chen, 2009). However, interested students try harder and persist (Hidi, 1990; Hidi & Harackiewicz, 2000) and incorporating students' cultural experiences into academic activities improves their interest and engagement which can translate into improved academic performance (Mensal, 2011).

It became clear, after spending some time with these children that engaging activities could have the double benefits of easing their transitioning into the US culture while facilitating learning. This could therefore be accomplished if children are familiar with the activities and attach personal relevance to what they do. For example, studies have shown that students' interest comes from prior experience, personal relevance, or their ability to relate to or with content or object (Bergin, 1999, 2016; Hidi & Harackiewicz, 2000; Renninger & Bachrach, 2015). I therefore hypothesized that math content that uses soccer—for students who are interested in soccer—will improve their engagement in math and subsequently increase their learning gains.

Research questions

This study answered three main questions:

a. Can participant observation research elucidate the learning needs of immigrant and refugee children?
b. Can PBL improve students' engagement in STEM?
c. Does culturally relevant content engage immigrant and refugee students in learning?

To answer these research questions, this study used multi-tiered research methods. First, I participated in and observed the afterschool activities of ACE during an 8-month period. I built relationships with the children and observed the wealth of diversity and experiences among the students. I kept journals during my visits and conducted informal interviews to learn about the students views on school and learning.

Second, I completed a series of project-based learning lessons during the Saturday STEM enrichment programs. An already slotted STEM sessions gave me the opportunity to design and teach a series of STEM lessons aimed at answering one important question: can project-based learning improve students engagement in STEM learning. I designed a math lesson with the story of Pele, the Brazilian soccer star, and a project on the human digestive system.

Lastly, I designed an experiment to determine how culturally relevant contents, could engage the students in math learning. In a 2x2 within subject design, the students were exposed to a no soccer content (control) and a soccer content (treatment). After the lesson, students answered a 10-item interest survey on their interest levels. Two observers rated the students' levels of engagement using rubrics that I had prepared during the research activities.

Chapter 2: BACKGROUND/LITERATURE REVIEW

A lot has been studied about immigrant and refugee experiences in the US. Some of these are primary accounts, but many are secondary accounts. To develop effective academic strategies to support immigrant and refugee children, this chapter explores three themes that could be harnessed to close the educational gap between immigrant and refugee children and their native-born counterparts. The first theme established the importance of incorporating culturally relevant content in learning. The second theme lays out how engaging content stimulates and improves unmotivated students' interest in learning. The last theme argues that sports could be used as a vehicle to improve STEM education for students who like sports but do not benefit from the regular STEM clubs that have been shown to improve STEM education for students, mostly those from rich families.

2.1 The Mediating Role of Culturally Relevant Content in Learning

Human development is characterized by the possibilities and constraints of both biology and culture (Rogoff, 2003). Without any biological deficit, however, culture is the biggest influence on learning. A contextualized idea, for example, is easily grasped compared to abstraction (Brown, Collins, & Duguid, 1989). This idea was thoroughly and exhaustively developed by Miller and Gildea's (1987) study of language acquisition and development. They found that language acquisition does not occur only by listening or reading words, but by speaking as well. Words we read and hear rarely remain in memory. Instead, when used, we learn language faster. This mechanism is not different from any form of learning.

Culturally relevant content is important to the learning process especially when it pertains to math. Learning is the process whereby an organism's interactions with its environment lead to a relatively permanent change in stimulus-response (Lachman, 1997). For effective and enduring learning, the students must be psychologically stable (regarding mood and mental state), and the materials must be relatable, familiar, or simplified for easy comprehension. For example, we learn better when we can make sense of the information through association, elaboration, and deeper processing (Craik & Lockhart, 1972).

Our attention toward a particular object of interest is a great contributor to effective learning. Consciously channeling all our mental resources towards a particular object of importance or situation facilitates learning. However, learning is impeded when attention is divided among two

or more materials or situations (Strayer & Johnson, 2001). That is, learning requires focused attention. Things we attend to are first registered in our senses, then in our working memory, where manipulations occur for storage in the long-term memory (Baddeley & Hitch, 1974). The manipulation of stimuli in the working memory greatly contributes to the learning process in terms of the amount of information that can be learned and the way it is processed. The complexities of a particular material, the external stimuli, and our knowledge influence the amount of information that can be contained in the working memory.

Students do not come to school tabula rasa. Instead, they come with their own rich histories, family dynamics, experiences, and curiosities. When these experiences are connected to learning materials and content, things are made concrete and meaningful, and these are the precursors to interest development and enduring learning (Campbell & Campbell, 2008). When students are given choices, engaged in dialogues, and/or observed during free play, instructors and educators will learn more about what students already know or would want to know. For struggling and underrepresented students, humanizing the learning experiences by incorporating their cultures, histories, and experiences would improve learning and their academic performance (Bartolome, 1994).

Children's understanding of the shape of the earth is an illustration of the influence of experience on learning. English children and Australian children live less than 10,000 miles apart. However, Australian children acquire the concept of the spherical earth earlier than English children (Siegal et al., 2003). To understand the spherical nature of the earth, children must first understand the concept of gravity (Shtulman, 2017). Australia is commonly referred to as "the land down under", but people in Australia do not fall off. As children grapple with this intuitive tension and contradiction, gravity would make sense and eventually facilitate their understanding of the sphericity of the earth (Shtulman, 2017). Conversely, Indian children who have had no experience with artifacts like the globe and maps would struggle to understand the earth's sphericity. Indian children, for example, perceive the earth as a dish that floats on water because of the cultural mythologies that have been transmitted from one generation to another (Samarapungavan et al., 1996).

Instead of finding the appropriate teaching method, Bartolome (1994) suggests that educators should rather incorporate what students already know. In the past few decades, this approach to teaching has been termed culturally appropriate pedagogy (Au & Jordan, 1981),

culturally congruent (Mohatt & Erickson, 1981), culturally responsive (Cazden & Leggett, 1981; Erickson & Mohatt, 1982), and culturally compatible (Jordan, 1985; Vogt, Jordan, & Tharp, 1987). Despite the semantics, all these approaches point to one fundamental question: looking at the mediation of culture in learning, how can educators make learning part of the students' culture? Thus, what must be done in order not to divorce what students do at home from what they do at school (Pewewardy, 1994)?

It has however been shown that incorporating students lived cultural experiences, especially students of a minoritized group have not always been received warmly. Attempts to stamp this out from the education system have been pervasive and consistent because of the fear that it will disrupt the neoliberal hegemonic world order (Sleeter, 2012). Some educators have a simplistic view of the approach to teaching and learning and tend to trivialize it sometimes (*ibid*); to these teachers, culturally relevant learning is the learning about a particular culture other than the predominant culture. More importantly, the lack of robust research that aims to link how and why culturally relevant interventions improve learning has been a major reason for the marginalization of this approach to teaching and learning (Nasir & Hand, 2006).

Despite contemporary alternatives (Hess & Shipman 1965; Lewis, 1969; Scott, 1981) that pointed to the sociocultural factors contributing to low Black academic performance, the work of Arthur Jensen linking IQ to biology still seems endemic. Jensen (1969) argued, albeit erroneously, that Black people are inherently less capable than white people. This intellectual superiority is heritable and therefore passed on to children by their parents. As a result, White people would continue to be intellectually superior but Black people have no chance of overcoming this biological difficulty. This idea has continued to lurk around in part because, despite a coherent and robust theoretical explanation for the relationship between culture and learning (Nasir & Hand; Rogoff, 2003), research that demonstrates the effects of culture on learning remains fuzzy (Sleeter, 2012).

A critical look at the literature indicates that culture gives meaning, makes lessons engaging, and influences the cognitive processes of a text (Tatum, 2006; 2009). The poor performance of young, Black boys has long been documented. Tatum (2009) argues that by assigning books that portray the experiences and background of these students, they would be more engaged because materials will make sense as they become relatable. A case in point as he pointed out was the wide reception of Franz Fanon's "Wretched of the Earth" (Fanon, 1963) by African American

men in the 1960s who yearn for the meaning of their plight and Thomas Paine's "The Rights of Man" (Paine, 1791) and "Common Sense" by the founding fathers of the United States (Van Deburg, 1992). It was not that these books were seminal—although they were, they received wide reception because they were the experiences of the targeted audiences. The content was relatable and made sense to the readers.

Learning can be difficult, and some students give up when they feel helpless. Drawing on students' backgrounds and experiences can be the needed classroom asset that can improve learning (Gay, 2010). This asset—their cultural background—research has shown, can improve students' attendance, especially for minority students who feel left out of school activities (Byrd, 2016). When struggling, students are more likely to persist because as agents in their culture, individuals actively influence their culture as their culture influences them (Rogoff, 2003). This persistence improves engagement and subsequently improves interest as students re-engage with academic content that is familiar and relatable (Christianikis, 2011; Deci & Ryan, 2000; Rodriguez et al., 2004).

Empirical evidence does not only support the efficacy of culturally relevant teaching, students who benefit from this approach to teaching also have a positive outlook of it (Byrd, 2016). For these students, who are at the critical moment of their identity formation, the opportunity to learn within their culture at school further supports their identity formation (Thomas et al., 2008), and this positively formed identity is related to academic persistence and subsequent academic achievement (Drake et al., 2014). A culturally sensitive school environment creates a sense of belonging because students see themselves as equal to other students and as important as other students.

2.2 Improving engagement through interest development

Interest is one of the important precursors for learning, meanwhile students' interest in learning steadily declines as they grow older (Hidi, 2000; Sason & Morgan, 1992). Decline in students' interest in learning is usually noticeable by third grade (Anderman & Maehr, 1994) because that is when lessons transition from concrete to abstract (Dewey,1913, 1938; Bruner,1962, 1966). When learning is decontextualized, it is no longer practical, and neither is it valuable to the learner. Students are therefore put off by this phenomenon. Their intrinsic

motivation to learn for its own sake as they have done not long ago as toddlers and little children with insatiable curiosity is turned off.

Boredom is also a major cause of students' declining interest in learning because when students are bored, they are less likely to focus on content (Larson and Richard, 1991; Smith, 1981). Boredom can therefore have detrimental effects on their academic performance (Larson, 1990). Since unnecessary repetition and the lack of enriched varied learning experiences breed boredom (Smith, 1981), designing engaging lessons to improve student's interest has become the priority of educators (Morgan, 2010). For example, students' interests improve when they can relate to learning materials (Cordova & Lepper, 1996). Students find utility in relatable materials. This apparent usefulness of learning materials can ignite and gradually maintain their interest.

Interest is a "relatively enduring predisposition to re-engage content over time". There are two types of interest: individual (personal disposition to reengage a content. This disposition is relative: can be short-lived or enduring) and situational interest (environmental triggers/stimuli that direct attention (Hidi and Renninger, 2006). Since students in most cases loose personal interest in learning as they grow, creating a stimulating environment through content relevance, novelty, challenging tasks, and sometimes hands-on activities is needed to enhance students' interest (Bergin, 1999).

Interest is a universal and observable construct (Renninger & Su, 2012). It can change, can be developed through personal efforts, and can be nurtured to develop by other people or some environmental situations (such as a stimulating environment). Interest is also an essential ingredient for learning (Hidi, 1990). Meanwhile, interest was largely neglected in educational research until the early 1980s. This was, in part, due to the difficulty with construct definition and its overlapping meaning with intrinsic motivation (Boekaerts & Boscolo, 2002).

Improving students' interest begins with a trigger (catch) and its eventual maintenance (hold). To improve students' interest in a particular content or an object, the environment or content must be engaging to draw the person's attention (Dewey, 1913; Hidi & Baird, 1986). An attention-grabbing situation might be a new object, contrasting thoughts or ideas, challenging problems (using puzzles or games), and relevant content or objects to the students. Prior knowledge can also improve interest. For example, after minimal exposure to a situation, a phenomenon, or an object, a child may ask further questions. Sometimes a light might spark

through these personal inquiries (which began due to prior knowledge) and would lead to a re-engagement with that content or object (Hedges and Cooper, 2016).

When triggered, the person then engages with the content or object, or situation (Bohnert, Fredricks, & Randall, 2010; Fredricks, Blumenfeld, & Paris, 2004). The engagement does not guarantee a subsequent re-engagement. However, in some cases, this initial engagement might prompt a further re-engagement leading to a sustained interest (Guthrie et al., 2006; Harackiewicz et al., 2008; Palmer, 2004; Rotgans & Schmidt, 2011a). Interest can be said to have developed when the first three have accrued: from the initial situational trigger that draws your attention to the subsequent re-engagement with the content or object. The figure below shows soccer content can be used to develop interest in math for students who are disinterested in math. Building on Dewey' "catch" and "hold", soccer content will first catch their interest and subsequently hold the students' interest in math.

Figure 1: interest development with familiar content

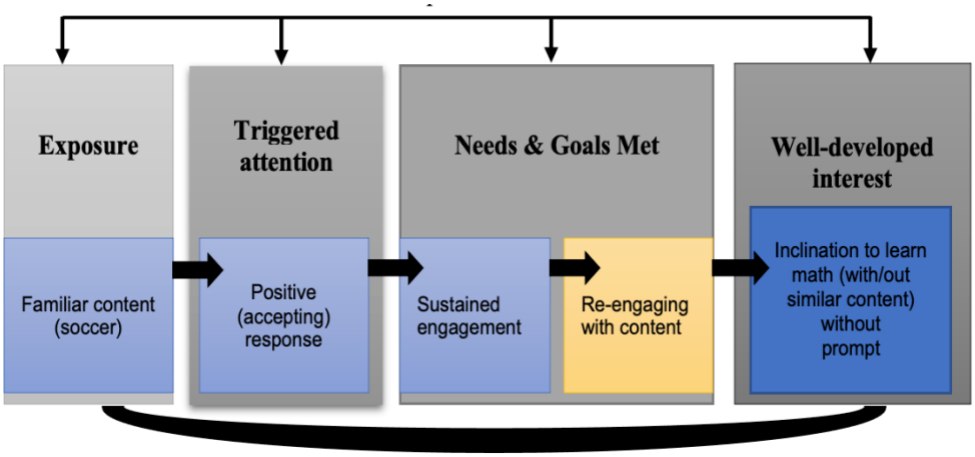


Fig. 1: Interest development. Using soccer content to improve interest in math for students who are interested in soccer. Adapted from Bergin's (2016) interest development model. Also, see Hidi & Judith (2000) and Hidi & Renninger (2006). Interest can develop when content is relevant, in this case, soccer is a well-known sport and an integral part of the lives of the students.

The main effort in interest research has been to answer why person A does this or doesn't do this and how can we make person B do activity X instead of activity Y. This was one of the major reasons for the neglect of interest research in education because these were the same fundamental questions posed by motivation researchers dating back to Ivan Pavlov. However,

despite their intuitive similarities, interest and intrinsic motivation are two distinct constructs. This notwithstanding, these two concepts have been used interchangeably (Schiefele, 1999). In his work, Schiefele argued that, in fact, interest and intrinsic motivation are two different constructs, and that interest, especially situational interest, is the precursor or a precondition for an individual to behave or not to behave on certain manner. This distinction was most likely influenced by Dewey's (1913) distinction between catching and holding one's attention.

Motivation research has been concerned with externalities (Harackiewicz & Sansone, 2000) but interest research has been concerned with internal state of the person (Bergin, 1999). Interventions for motivating students have largely relied on reinforcements such as rewards. On the other hand, attempts to improves interest have relied on making connections to students' internal states such as content relevance, challenging problems, puzzles, relatedness, personal values, and vicarious needs (Bergin, 1999). In addition, what drives people (or motivates people) can be for mastery or achievement (Nolen & Haladyna, 1990).

Measuring the existence or non-existence of interest requires a multifaceted approach. Most researchers have used self-reported instruments like questionnaires and interviews. Mitchell (1993) for example, developed an instrument that measures students' interest in math with an emphasis on situational (environmentally stimulating) interest. The 38-item instrument asked students to rate how personal/situational interest, meaningfulness, involvement, group work, puzzles, and computers could improve their interest in math. Similarly, Luo and colleagues (2019) also developed an instrument to measure students' interests. It was specifically developed to measure Chinese adolescents' interests, but it is applicable to other school-age children. It measures general academic interest but can be tailored for a particular subject. This 29-item measures students' emotions, values, knowledge, and engagement.

2.3 Improving Interest in STEM for Underrepresented Students Using Out-of-school time Sports

Over the past decades, the federal and local governments have embraced out-of-school-time as essential for a complete educational experience for school children, especially children who come from low socioeconomic backgrounds. These programs serve as supplemental academic and socioemotional resources for the students. In some cases, skills learned in these programs translate into students' academic progress. Most out-of-school programs provide homework

support, one-to-one tutoring, as well as enrichment non-academic programs such as art, craft, dance, etc. Whereas some out-of-school time run throughout the school year, others last through the summer when students are on break.

FIRST (For Inspiration and Recognition of Science and Technology) is an example of an out-of-school program. FIRST is a 6-week summer boot camp for high school robotic enthusiasts. This is a highly selective program and only a few students make it. Students who are selected work with their coaches over a 6-week period on robotic projects. These students, through this activity, learn important communication skills, teamwork, and interpersonal skills, problem-solving and time-management skills, and how to apply traditional skills to real-life situations/problems (Melchoir et al., 2005). Reports from Melchoir and colleagues found that 87% of FIRST students took at least one math course in college. 78% took at least one science course in college. 51% took at least one engineering course. About 60% of FIRST alumni had at least one science or technology-related work experience (internship, apprenticeship, part-time, or summer job).

In addition, 40% of female FIRST alumni took engineering classes, 59% had a science/technology internship or job, 41% percent of African American alumni and 53% of Hispanic alumni took engineering courses, 64% of African American alumni (but only 29% of Hispanic alumni) had science/technology internships or jobs. Overall, FIRST students were more likely to major in Engineering than the average college student nationally. 41% of FIRST alumni were more likely to become Engineering majors compared to the national average of 6%. Similarly, 33% of female FIRST alumni, 27% of FIRST African American FIRST alumni, and 47% of Hispanic FIRST alumni majored in engineering compared to the national averages of 2%, 5%, and 6%, respectively. More so, FIRST alumni were more likely to attain higher education compared to national averages. For example, 78% were expected to attain post-graduate degrees.

Despite the promising findings from this program, especially, how likely it is for a participant in this program to end up doing something related to the program in college and after, it would be too simplistic to attribute the future endeavors of these high school students to just a 6-week engineering boot camp. This program cannot be the solution to improving minority representation in STEM. These programs are optional, and as a result, self-selecting. It is more likely that only students who are already interested in robotics (and more likely to come from

affluent families who could afford similar materials for them at home) will attend the programs (Gottfried & Williams, 2013). Students who need these programs (usually from poor families and are already underrepresented in STEM programs and careers) are less likely to attend (President's Committee of Advisors on Science and Technology, 2010).

Similar programs such as math and science clubs and LEGO competitions have been shown to have promising effects on students' performance in STEM. In a math and science club, the authors found that club participation improved students' science and math performance, as reflected in their GPA. Further analysis showed that participation was correlated with students' socioeconomic status. Children from rich families were more likely to participate in math and science clubs compared to children from poor families (Gottfried & Williams, 2013). Students from rich backgrounds receive childhood exposures that nurture their interest in science and math. Also, an analysis of an annual LEGO competition aimed at improving interest in science and technology showed that there was a minimal effect on underrepresented students compared to students who already had robotics as part of their curriculum. Most of these children were from affluent backgrounds. Pre- and post-analysis also found that interest did not change a lot because most of the children were already interested in LEGOs as indicated in their initial self-report prior to the study (Karp & Schneider, 2011). This also shows an example of self-selecting STEM enrichment program.

Sports, both at school and after school are an integral part of the lives of most underrepresented students. These children play soccer, basketball, baseball, and all kinds of sports. Most of these children like sport because it is fun and engaging. Left alone, they would play from dawn to dusk. While most of these children are sports enthusiasts, only a handful of them become professional athletes, etc. According to the NCAA research (2016) for example, out of about a million (including males and females) high school athletes, only about 3.6% later play in the college teams and only 8.7% of these college basketball athletes would continue to play professional basketball. That is, a high school athlete has only about a 0.3% chance of securing a spot on any of the professional basketball teams.

The minimal career prospects in sports for underrepresented students do not deter them from sports. Sport is fun and engaging. These children learn essential life skills such as teamwork and cooperation, and for many of them, playing sports after school keeps them out of trouble. Their already developed interest in sport, like rich students' interest in STEM club participation and

LEGO competitions, offer a unique opportunity to channel their interest into STEM using sport. For immigrant and refugee students, soccer has been shown to be an effective medium, not only for smooth integration and resettlement, but for the developing of socio-emotional skills needed to succeed in the schools of their newly adopted homes. Using sports does not require additional STEM materials, instead it uses what the children already know to help them develop the skills they would need to succeed.

As indicated in the FIRST and LEGOs projects, STEM education is not school bound. Out-of-school programs can provide STEM enrichment resources for disadvantaged and underrepresented children. These STEM outreach programs must not necessarily be restricted to high-tech robotic equipment which, in many cases, are lacking in most inner-city outreach programs. These program centers can still assist their students with STEM programs with low-cost materials that are available and reproducible at the various outreach centers. In their case study, Drazan et al (2016) supported inner-city children who play basketball to learn engineering skills by building vertical jumps. The students were already interested in basketball and the materials were readily available. Students who would have otherwise not had the opportunity to learn these engineering skills at the summer engineering boot camp or at their school's engineering club now have the chance to learn these skills with sports they play regularly for fun, etc.

Whereas active learning: learning by doing say designing jumping hoops to play basketball improves learning, other studies have also found that the incorporating sports content without engaging in the sport can trigger students' interest, prompt re-engagement, and inevitably improve learning (e.g., Drazen et al., 2017; Eglash & Garvey, 2014). Despite their interest and underperformance in STEM, the interest and performance of underrepresented students in sports are phenomenal. This provides a window of opportunity for educators to use sports to catch and gradually hold their interest and subsequently improve their performance in STEM.

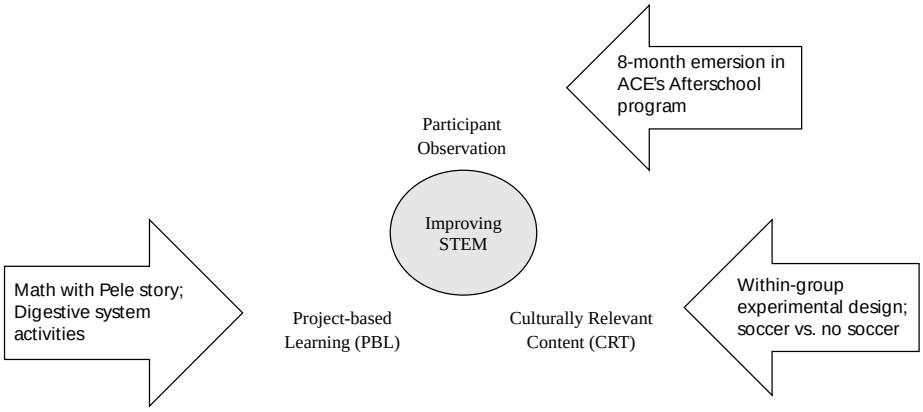
Chapter 3: METHODOLOGIES

This study used multi-tiered research methods to answer the three research questions. First, I participated in and observed the afterschool activities of the African Community Education (ACE) during an 8-month period. Through participation, I built relationships with the children. As an observer, I realized the wealth of diversity in experiences among the students. I kept journals during my visits and conducted information interviews to solicit the views of the children regarding school and learning. In the end, it became clear that these children are not academically incompetent, nor do they exhibit problem behaviors as others might assume, but their transitioning into the new environment poses a challenge to learning. The afterschool program was a great resource needed for their optimal growth and development as well as to bring their academic performance at par (and beyond) with the native born.

Second, I completed a series of project-based learning lessons during their Saturday STEM enrichment programs. Aside from the usual weekday homework support, one-to-one tutoring, art and craft, and other activities, Saturday STEM is an important aspect of the ACE's program. The students have two STEM sessions, play soccer, sometimes embark on STEM fieldtrips, drum, and dance, etc. An already slotted STEM sessions gave me the opportunity to design and teach a series of STEM lessons aimed at answering one important pillar of the agenda: can project-based learning improve students engagement in STEM learning? I designed a math lesson with the story of Pele, the Brazilian soccer star, and a project on the human digestive system.

Lastly, after determining the extent to which PBL alone can improve the students' level of engagement, I designed an experiment to determine how culturally relevant content, coupled with PBL, could also improve the students' engagement. In a 2x2 within subject design, the students were exposed to a no soccer content (control) and a soccer content (treatment). After the lesson, students answered a 10-item interest survey on their interest levels. Similarly, during the lesson, two observers rated the students' levels of engagement using rubrics I had prepared.

This diagram shows the multi-tiered research method adopted for this study



3.1 Can Participant Observation Research Elucidate the Learning Needs of Immigrant and Refugee Children?

Educational research related to improving underserved children are wide and varied. Most of these studies target clusters of students with similar school experiences such as those from the same class or school. Some also randomly assign treatments to different school districts to test the efficacy of certain interventions. The framing of educational research questions is the key factor in the sampling of the research methods. Whereas these studies largely start and end in the classroom, students spend most of their time in their homes and in community centers such as afterschool programs. Due to the predominant educational research questions which influence methodologies and sampling, investigators are usually unable to capture an important part of how to effectively support students – particularly how these students spend their time after regular school hours.

To understand the learning needs and to learn how best to support immigrant and refugee children who come from different cultural backgrounds, I adopted a participant observation

research method at the ACE. Through the participant observation method, I engaged with the students during the 2021/2022 school year (in an 8-month period). My first day at the program was September 15, 2021, and June 9th was my last day with the students. During the fall, I spent at least four hours on weekdays and five hours on Saturdays. This time changed during the last few months of the spring semester. During this time, I spent two hours, usually from 3:30 pm to 5:30 pm (i.e., one weekday encounter) on the weekdays but the Saturday hours remained the same throughout this period.

3.1.1 Theoretical Framework:

A participant observer is a researcher or an investigator who becomes part of a community and observes the behaviors and daily activities of the people. Participant observation is "the systematic description of events, behaviors, and artifacts in the social setting chosen for study" (Marshall & Rossman, 1989, p.79). This process includes "active looking, improving memory, informal interviewing, writing detailed field notes, and perhaps most importantly, patience" (DeWALT & DeWALT, 2002, p.vii).

Participant observation research method dates back, at least centuries. It is a featured form of ethnographic research. Participant observation research method was first used by the anthropologist Francis Hamilton Cushing (DeWALT and DeWALT, 2002). Cushing lived with the Zunis of New Mexico for four and a half years around 1879. He went through all their cultural initiations, practiced their customs, and in essence, became a *naturalized* member of the community. He was initiated into the Zuni Bow Priesthood after living with them for some time and was deemed fit to be part of them. He, however, did not write much about his experiences living with his research participants, so much of what he learned is unknown. The little he wrote about this community provided an invaluable insight into the lives of the Zunis. His research approach also established the participant observation method of anthropological research. As he indicated, this research method aims at "endeavoring always to place himself as much as possible in their position, not only physically but intellectually and morally as well, [to] gain insight into their inner life and institutions" (Auerbach, 2008, pp.21).

Cushing’s work and approach inspired others who wanted to learn about groups of people by immersing themselves into their daily lives. In the 1880s, Beatrice Webb studied the lives of the poor in urban Chicago (Guest et al., 2013, pp. 76). Unlike Cushing, she did not make a

permanent dwelling with the poor in the community but found other ways to obtain the information she needed. To get a closer look at their behaviors, she secured a job as a rent collector, and this brought her closer to the people as they struggled to earn a living and maintain their housing. She also became a seamstress and worked in one of the community dressmaking shops. This further brought her closer to the urbanites of Chicago who were destitute and struggled to earn a living.

Similarly, in the early parts of the 1920s, Bronislaw Malinowski (1922) studied the Trobriand Islanders. Webb strictly followed the Cushing's approach of living within the culture he wanted to study. Unlike Cushing, she was not initiated into the lives of the Islanders and that gave her the liberty to write extensively about what she learned and how she learned. This established her as an authoritative voice of anthropological research that used the participant observation method (Bernard, 1998). Margaret Mead, a contemporary of Malinowski also lived with and studied the lives of Samoan adolescent girls. Her research was only focused on certain aspects of the lives of the Samoan girls and not every detail of their lives. Her work also threw more light on the efficacy of using participant observation method to study *cultures*.

The participant observation method, like most research methods, is not without flaws. Since this method heavily relies on note taking and memory recall of events, the difficulty with maintaining the observer status and keeping notes while participating in the daily lives of your participants is an arduous task. Francis Cushing, the pioneer of this method is an example. It has been found that his complete immersion into the Zunis culture interfered with his work and he would either not keep accurate information about what he observed and heard or would fake some of the information in order not to offend the Zunis (Kawulich, 2005). Despite the difficulties, however, the participant observation method is doable and sometimes offers the most effective method for conducting research.

Over the years, others, realizing the challenges, have devised effective strategies to facilitate this research and to prevent complete naturalization into the culture to be studied. The first step is the physical presence of the researcher. As the method suggest, the observer is also a participant in the activities of those he/she is studying and must therefore be present. After being there, the researcher is then required to engage with the people, build rapport and establish meaningful relationships geared towards obtaining the data to answer the research questions. Lastly, since there is no fixed duration for data collection, the amount of time needed depends on

the questions to be answered and how long the researcher can afford to continue the study (Participant Observation WHAT IS PARTICIPANT OBSERVATION? n.d.).

The ACE offers a unique opportunity to learn from immigrants and refugee students from Africa by being part of them. The ACE is an afterschool program that serves immigrant and refugee children from 5th grade through 12. These students receive homework support, one-to-one tutoring, art and crafts, and games from Monday through Thursday. Since 2006, ACE has served more than 450 refugees in the Worcester Area. ACE has a 98% graduation rate compared to the Worcester Public School graduation rate of 80%. Also, 89% of ACE graduates enroll in college after high school compared to the 65% enrollment rate of the Worcester Public School.

3.1.2 Methodology

Participants

Participants included boys and girls from grades 5 through 12, with an average of 15. All participants are from the Worcester school district, with an overwhelming majority coming from the public schools. All participants are either refugees or immigrants from Africa and are all English learners but some, especially those who arrived as younger children or arrived more than 5 years ago are proficient in the English language. However, some speak their local dialects at the program. Whereas English served as the main medium of instruction, some staff would sometimes teach the students in the local language such as French or Swahili, etc. Daily attendance averaged 20-30 students with fluctuations, with sometimes higher and sometimes fewer students.

Relationship building

Building meaningful relationships and establishing rapport is an indispensable condition for participant observation research. Time must therefore be devoted to knowing and being known by your participants. I made time for the all-important aspect of my research. I learned the names of the students, the staff, and volunteers, and I would always mention my name, my institutional affiliation and country of origin to establish common ground, especially with the students. Similarly, I would ask the name of the students, the name of their school, country of origin, how long they had lived in the US, and their first language. This approach paid off and halfway

through the fall semester, 2021, I had become acquainted with most of the students, so I stopped asking their names because I remembered it (at least for the regular attendees). Despite my initial assignment to mostly high school student, I would occasionally join the other groups, who were mostly middle and elementary school students, to talk with those I have never met. When assignments are completed and my assistance is not needed anywhere, I played table tennis and foosball with the students.

An important part of my visit was the announcement time. The waiting period for the announcement was also lunch time. The students usually gather at the auditorium, and on the tables were board games such as *connect 3, Oware, UNO*, and a few others. I usually sat by some students for a chat or play one of these games with them. In fact, I learned the *Connect 3* game and *UNO* from the observation of and engagement with the students. Every Thursday was a raffle day and the students enjoyed it. Students who had attended at least three program days were qualified for the raffle. The after-school coordinator would usually call on one volunteer or a staff to select a number within a range (from the number of students who qualify, say 15 students). The accompanying name to the selected number wins the raffle. Mostly, one person is selected but sometimes, more than one is selected. The raffle served as incentive for regular program attendance.

The program also served as an important avenue for the students to learn and meet new people in the community. The US ambassador to Nigeria, who is a Worcester native and an alum of the current school of some of the children, visited the students. She encouraged the students to work hard and consider a career in the foreign services. Representatives from the Worcester District Attorney's office also came to educate the children on law and order, as well as how to access legal assistance when needed. Insurance agents, and representatives from the Quinsigamond Community College, the preferred college for most of the students, also came to present the opportunities and the importance of choosing the community college to either complete their college experiences or complete a two-year program to obtain the needed credit to transfer to another four year in-state college.

These meetings and encounters were opportunities for the students to learn things they would not have known or might have taken years for them to learn had they not attended the program. Most importantly, these special events were usually announced and advertised at least a week prior, so the students are aware and to attend.

Data Collection

I took notes of my time with the students. I began every note with the date/day, time, and place (s). This was followed by the announcements for the day. I will indicate the number of students present at the time of the announcements. The estimated number of volunteers that are present were also recorded. New students I had never met were also recorded. Special occasions such as a visit from a community leader or persons from partner or non-partner organizations and the purpose of their visit was recorded.

I recorded the names of the students I worked with, the subject we completed, the grade level, and the name of the school the student (s) attend. I paid attention to their actions, especially their reactions towards certain questions, their comments, and answers to questions I ask them, and their attitudes towards their homework completion i.e., whether they are willing to continue with the work or end it when they get stuck on a question, as most of them often did.

The validity of participant observation research depends on the accuracy of the notes of the investigator. Therefore, accurate recorded notes become the primary data source. I kept notes on all my visits. These notes are sometimes taken in shorthand but are expanded immediately after the program ends. Despite the difficulties, direct quotes are sometimes captured in my notepad. Some of these quotes could be words or phrases. Occasionally, I got full sentences and complete thoughts from the students. I reviewed my notes again later that day and this gave me the opportunity to think about how the day went. At this time, I would usually add my own reflections to the journal entry captured as “some thoughts”.

I had two record-keeping techniques. I used my notepad and my phone. First, as a volunteer, I provided one-to-tutoring to the students, and I always had a notepad and a pencil in hand. For the first few weeks, I would ask the name of the student that I tutored, his/her grade, country of origin, how long he/she has been in the US, his/her favorite class, and a few other things. The name and grade level were always asked after the students tells me the subject he/she needs help with and then as we go through whatever work the student had, I would occasionally ask one of these questions casually or as an example or to establish a relationship because I would always end by disclosing that I come from Ghana and I have been in the US for X number of years. Aside from my notepad, my primary mode of documentation was my phone. I would

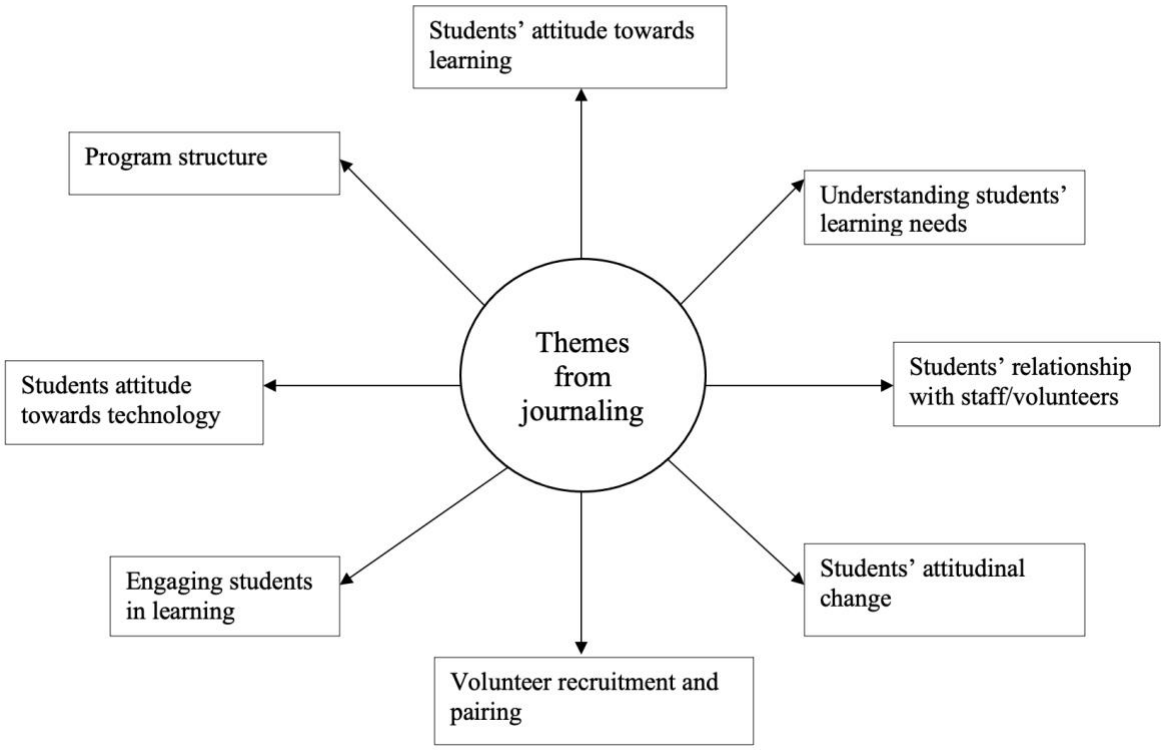
always open my google keep app or the notes app on my phone whenever I get the chance. I took notes with my phone when taking out my phone will not interrupt what I am doing.

Observation

The students always dress appropriately for the weather. Most of them have known each other for years and have become friends. Some speak the same native language and that was usually preferred over English. Most of the staff were Africans, could speak the languages of the students and as result, are able provide the needed support whenever language becomes an issue. With a few exceptions, students who came to the US as children and have spent more years were more engaged during conversations compared to their peers who have been in the US for a few years. They had regular eye contact, were less attached to their devices, and–with a few exceptions-did not attend the program regularly.

Some themes emerged from my journaling.

This diagram shows the themes that emerged from my journaling



Most of my journal entries ended with my personal reflections on what I have recorded. The themes emerged from these reflections. The diagram above gives an overview of the themes. The table below shows the journal reflections as recorded in my journals. I have changed the names of the students for anonymity. Other than the names, this are the exact reflections from the journals.

This table of journal reflections, from which the themes emerged.

	THEMES FROM MY JOURNALING
1	**Program Structure**
	1. How would pairing one volunteer with the same child(ren) for a considerable amount of time affect their learning outcomings. 2. I would like to know more about the work of the public-school liaison for ACE. What does she do? Her engagement with the schools? Her point of contact at the schools? Any plan in school for identified at-risk ACE students? etc. 3. They have divided the group into classes, according to age and grade. Each class has a teacher or leader. An ACE staff. Adding one or two permanent tutors to the classes with volunteers, I think, will go a long way to improve the kids' academic work. Though this may require hiring permanent tutors, I think they can do that every semester by sending out hiring flyers to the Worcester colleges and universities.
2	**Understanding students' learning needs**
	1. Do they have more background information about the kids they serve? E.g., grades at school, home support, etc. 2. Anything to evaluate kids academic standing (e.g., reading fluency and proficiency) on their first day at the center? This will help them identify the kind of support the child needs. 3. Learning about children's level of support and providing the needed support seems ideal. Some of the kids need more help than others so the support must be assigned accordingly

3	**Students attitude toward technology**
	1. One dimensional technology. I have observed that most of their homework are assigned via Google Classroom. They usually log in, access their homework, complete, submit, and shuts down the Chromebook. The Chromebooks seems to have no use to most of them other than homework completion. But I have seen that these kids have other class materials such as power point and reading materials on their Chromebook, but it seems they have associated their Chromebooks with homework (and games). No google search for information. No reading on their devices. Is there something to this behavior or I am just making something out of nothing?
4	**Engaging students in learning**
	1. Keeping the children engaged for 1 hour is a tough job. Many of them can't sit still for more than 5 minutes. They are either talking or looking at their phones. I think doing 20 minutes then breaking for 5 or 10 minutes should be considered. 2. Students were instructed to continue reading from where the next person ended. Most of them read just a sentence or two. As a result, students followed along and paid attention. This is a way to improve their reading and communication skills.
5	**Volunteer recruitment and pairing**
	1. "This math is hard. It's nothing like I have ever done before". This statement by the volunteer plus similar statements from other volunteers and staff further support my previous observation of the need for qualified math and science tutors. If a college student finally admits that math is hard, it further depresses these students who are already struggling with math and science. And it reinforces their belief that math is hard and there is nothing they can do about it. They throw their hands in the air.

	2. Streamlining volunteer-child pairing. I don't know how this can be done. But, if possible, give volunteers a heads up on children they will work with. Again, this may be difficult if you don't know which kid is coming for tutoring.
6	**Students' attitudinal change**
	1. I was impressed to hear that Bernard intends to ask his teacher the next day to open the work for him. It is not something I hear a lot from the students at ACE. I later remembered that his name was among those on honor roll, so this attitude was not all that surprising. I think others too can learn to ask their teachers for help if they are reminded and encouraged by staff and volunteers. 2. To help students get more out of the after-school tutoring, staff and volunteers would have to advise them on the purpose of homework: not only for grades but also to learn the topic. They therefore must engage the students' sometimes let them take the lead while asking questions for clarification. Students should be allowed to "struggle" a little bit. This would be a difficult thing to start (looking at their perception that the afterschool tutoring is a time for a staff or volunteer do their homework for them), but it is worth with in the long run. 3. I was really impressed that John came back to me to demonstrate what I had discussed with him just two days ago. The perception among most of the kids is that they have come over for homework support, but they expect staff and volunteers to do it for them. The problem is that they don't learn much from their homework. Unfortunately, I don't know how to change this perception to get the students involved in their work, to ask questions and try to understand the questions. Maybe doing it one after another like what I did with John would go a long way.
7	**Students' attitude towards learning**

	1. Some students have also learned one way to do math. They can't think flexibly and are not willing (or probably not aware that there are other alternative ways to solve math problems. Plucking in the answer to demonstrate the meaning of the equal sign (finding that variables on both sides are equivalent), I believe, demonstrated a little bit of alternative ways to solve math problems. 2. The student's question about STEM and why we read a story shows 1) students' misconceptions and narrow understanding of STEM 2) how this approach to teaching STEM can also demystify students' fear of math and science. Stories like these might also improve students' interest and self-efficacy. 3. To help students learn math, people have developed different strategies, and the shooting game is one among many. I was just wondering if this is the appropriate way to help students, especially, boys who like games like this learn math. What impression is being created? Can this fuel some aggressive behaviors in boys as some studies have suggested shooting games does?
8	**Students' relationship with staff/volunteers**
	1. Mary has been in the US for about 7 years, and she was very little when she arrived. Her behavior is somewhat different from recent immigrants or refugees at the program. I have observed similar trends. At least 4 of the students I can think of: Benson, Charity, Baruch, and Cristina, are in this category. You can have a sustained conversation with them, and they seem to show interest in what you say. Their attitude towards technology is somewhat different. Mary, for example, was watching some videos on YouTube. You rarely see her glued to her phone. Katherine, at some point, logged in to her Netflix account to continue watching her show: Glow up. (This was the first time I have seen a student watching a movie on Netflix) But immediately shut it down to join others in their activities. She left her bag with me and would come back to check it from time to time. She will

	then start a short conversation with me whenever she comes back. Interestingly, she didn't have her cell phone and indicated that she has been without her phone for about a week, but she seems perfectly normal. A behavior I have not observed in the students who have phones. 2. I think her (and others) engagement and interest during conversations stem from her grasp of the English Language. There may be more to it.

3.2 Can Project-based Learning Improve Students' Engagement in STEM?

Saturday's program forms an integral part of the mission of ACE. Students play sports, usually soccer (but sometimes basketball). They participate in African drumming and dancing. There are seminars to learn about trauma, financial literacy, etc., and regular classes to learn socioemotional skills, purposely designed for the boys. These activities notwithstanding, about half of the time spent at the Saturday sessions are devoted to science technology engineering and math (STEM) activities. Instructors alternate between science and math. There are opportunities to engage in engineering activities. Some of these activities are organized by local universities where the students get the opportunity to play with robots and other gadgets. Sometimes, this equipment is brought to the program for longer engagement. Sometimes, the students embark on a fieldtrip. There is an ESL (English as Second Language) class for both elementary and high school students. All the classes are designed for both high school students and elementary school students, and they are project-based focused.

3.2.1 *Theoretical Framework*

Project-based learning is a form of instruction that is centered on students. It provides opportunity for inquiry and real-world problem-solving (Al-Balushi & Al-Aamri, 2014; Kokotsaki et al., 2016). Project-based learning is based on the premise that learning occurs as individuals interact with their environment. This is because learning is situational (i.e., context specific), learning occurs through an individual’s interaction with the environment, and individuals acquire knowledge and gain understanding through their interactions with other people (Cocco, 2006).

Project-based learning is rooted in the philosophy of constructivist learning. Constructivism posits that learning occurs through the active manipulation of the organism's environment. Organisms could be instructed to perform certain functions. However, to make sense of the environment, the active participation of the organism is required. Project-based learning involves students in the lesson, gives them options to try out new and sometimes challenging things, and provides the opportunity for students to not only think about the lesson, but about their prior knowledge on the lesson, a phenomenon called metacognition (i.e., thinking about your thinking). Metacognition, the idea that pausing to reflect or think about what you know, improves learning, dates to Dewey (1933, cited in Tanner, 2012). Through project-based learning, students' prior concepts are triggered and sometimes challenged as they confront new ideas. Students therefore learn to adapt what they know into new phenomena.

Individuals construct their worldview through observation. The constructed understanding of a concept, how an object looks like or behaves is called schemas – a mental representation. Through assimilation, new information is incorporated into these schemas. For example, people have a schema of a courtroom (a judge seated on a mounted platform presiding over cases, lawyers defending or prosecute alleged offender, etc. the same as a schema of a classroom). Schemas could last a long time as no new contrary experiences are encountered. Through new experiences, established schemas begin to crack. This new information fills up these cracks in the process called accommodation.

Jean Piaget (1952, cited in Nickerson, 2021) argued that learning occurs through assimilation and accommodation. Assimilation is the process whereby new information is absorbed into our existing schemas – mental representation of a phenomena. However, when we encounter new information that do not fit into our existing schemas, the new experiences are incorporated into our mental representation through the process of accommodation. For example, an individual who identifies the courtroom with an adversarial concept would have to revise that prior schema in an inquisitorial court where the Judge does the fact-finding through its own investigation instead of the adversarial where the prosecuting and defending lawyers find the *truth* of their case through cross examination, etc. Like PBL, students, not the teacher inquire about the content of the lesson and through that process acquire new insights.

Whereas Piaget's theory was individually centered, Vygotsky took a sociocultural approach. He opined that since the individual exists in the society, learning ought to be understood as a

collective endeavor. Vygotsky's theory of learning shifted the Piagetian person-centered to culturally and collectively centered (Gredler & Shields, 2008). This was made apparent in his argument that learning occurs through language – the language of the culture in which the learner resides. The sociocultural, as well as the linguistics influence on learning epitomizes PBL. In PBL, students usually work in groups and that means they had to communicate among themselves. As students develop their linguistic skills through PBL, so does their understanding. Through group work, individual wrong assumptions can be challenged and corrected.

The most important aspect of Vygotsky's theory of learning is the Zone of Proximal Development (ZPD). He argued that children, especially, learn through scaffolding – the step-by-step support and the simplification of complex problems into small bits. This happens as children improve their thinking from the basic to the advanced. This gradual development does not happen in a vacuum, it requires time and support. The two ingredients PBL affords. ZPD is analogous to PBL in the sense that through ZPD as in PBL, students start from scratch and work their way to the top. In PBL, for example, the teacher would pose the driving question. Through discussion, new ideas will emerge. The teacher, now serving as a facilitator or a coach, will ask further probing questions and through a series of activities, guide students to arrive at a solution.

Project-based learning is usually associated with and often misconstrued as either problem-based learning, experiential learning, or inquiry-based learning. Whereas project-based learning shares similarities with these pedagogies, there are fundamental differences. Project-based learning often involves problem solving. However, whereas both emphasize the process of learning, the final product of students is a distinctive feature of project-based learning (Blumenfeld et al., 1991). Similarly, whereas project-based learning involves real world scenarios and built-in reflections to allow students to think about what they know as in experiential learning or inquiry-based learning respectively, project-based learning is particularly outcome driven (Helle et al., 2006). These notwithstanding, project-based learning is not inflexible; instead, it overlaps with the pedagogies mentioned above.

Despite its popularity in the upper levels, project-based learning is not restricted to older students in high school and beyond. PBL has been shown to be an effective pedagogy for students of all ages and levels and even for non-academic organizations (Kokotsaki et al., 2016; Kwietniewski, 2017). For example, to determine preschoolers' readiness, Habok (2015) demonstrated that project-based learning could facilitate the children's experiential reasoning

and understanding of relations. Ljung-Djärf et al (2014) also found that PBL could trigger preschoolers' interest in science.

Through PBL, students acquire the skills they need to succeed in school and after school. Students learn how to collaborate with others and communicate their ideas effectively since most PBL lessons are grouped based. The opportunity to produce a product instills in students the creative and innovative urge and the critical skills to evaluate their progress. Most assuredly, PBL can meet the needs of all students. It can improve academic performance for academically struggling students (Cuevas et al., 2005; Doppelt, 2003.; Koutrouba & Karageorgou, 2013). To close the gender gap in STEM preferences and interests, (Barak & Asad, 2012 & Lou et al., 2011) found that PBL could improve teenage girls' interests and participation in STEM activities.

3.2.2 Methodology 1: Pele Math Activities

Participants

The participants included 12 elementary school students. They included boys and girls. All participants were from the Worcester school district and attend the ACE afterschool Saturday program. All the participants are either immigrants or refugee from Africa. Participants are proficient in the English language, although they are all English learners, and for some, English is their third language.

Materials

Materials included the printed materials of the day's lesson, pencils for class activities, rulers, and sheets for papers for exercises.

Procedure

The lesson began with an introduction. Students mentioned their names, grade levels, and the names of their schools. After the introductions, I introduced the lesson objectives, then distributed the lesson materials, which included pencils, sheets of paper, and a copy of the story about Pele, the Brazilian soccer player (see Appendix A).

Students read the passage in turns. Each student read a sentence, followed by another. That sequence was followed until the end of the story. After the story, I asked students to summarize the story in a sentence or two. Most of them talked about the lessons learned, a personal reflection that was included at the end of the passage. Using their plain sheet and pencils, the students were asked to calculate the goal difference between Pele and Arthur Friedenreich, another Brazilian superstar. The students had read that Pele has an overall career goal of 1,280 compared to 1,329 goals of his Brazilian counterpart. After this calculation, students were then asked to sketch a soccer field, label the length and the width, and using a ruler, measure and write the length and width of the soccer field they have sketched.

There was a supporting instructor in the classroom helping with class management and assisting students focused on task. Also, an observer from the National Institute of out of school time (NIOST) was present. This observer took notes as the lesson progressed.

Methodology 2: Science Activities

Participants

6 elementary school students, including 5 fifth and sixth graders and one seventh grader participated in this lesson. Participants were both boys (n = 4) and girls (n = 2). They were all in the Worcester school district and attend the ACE afterschool Saturday program. All the participants are either immigrants or refugee from Africa. Participants are proficient in the English language, although they are all English learners, and for some, English is their third language.

Materials

Banana, crackers, one bottle of lemonade (as stomach acid), water, Ziplock plastic bags, a plain plastic container, one Styrofoam cup as a funnel (with cut off bottom), one Styrofoam cup as a plunger, 1 cut-off leg of tights/stockings (i.e., small intestine), gloves, scissors, a Styrofoam cup with a hole as large intestine

Procedure

This was a three-part lesson which was completed in three successive Saturdays but only the first lesson, which was focused and completed the lesson activities, is reported here. Whereas the whole lesson plan has been included (see appendix B), only the results of the first day's activities have been included in this section. The lesson and accompanying activities were adapted from science journal for kids.org.

I started the class with the usual introduction: name, school, and grade. I added "favorite food" to the introductory questions to set the tone for the class. Students mentioned pizza, fries, rice, and chicken, vegetables, and fried chicken as their favorite foods. All the students participated in this introductory section of the class. After the introduction, two tables were put together and the materials were brought out and placed on them.

Students watched a two-minute video (obtained from the internet) of the class activity before they started. This helped them get the sense of what they were going to do. The video was included as a reminder for students who were absent today but will join the class in the subsequent classes for this activity. The students watched the video on a phone.

After the video, two students peeled one banana each. Another held a Ziplock open for another student to put the banana and cookies in it. Other students added lemonade (a substitute for orange juice) to the banana and cookies in the Ziplock and added water to it. Then the last student squeezed everything together with her hands. When the food was well mashed, one student squeezed the mashed bananas and cookies with the added water and lemonade through a cloth into an empty cup. The leftover solid was squeezed out of a Styrofoam cup with an opened bottom. Each step and the function of each material was explained to the students. I explained that the water was a substitute for saliva, lemonade was a substitute for acid, banana, and cookies as foods, the big Ziplock as the large intestine, and small thin long cloth (stockings) as the small intestine.

3.3 Does Culturally Relevant Content Engage Immigrant and Refugee Students in Learning?

Background: It has generally been thought that we learn by doing. Ideas that are reducible to action are easily grasped compared to those that are abstract. The gradual shift from concrete

representation of ideas to abstraction is one of the major causes for the reduction in students' interest as they progress in their educational lives. To test how students could be engaged in math learning, this section reports two studies that examined how immigrant and refugee children could be engaged through active participation in the lesson. Through a project-based approach, elementary and high school students completed two similar activities. Condition 2 incorporated soccer content (which was defined as a culturally relevant content) while Condition 1 did not include anything deemed culturally relevant yet, it followed the same project-based procedure as the former. Part 1 of this section reports the study with the elementary school students and part 2 reports the study with the high school students.

***Figure* 1** below shows the conceptual framework of using culturally relevant content

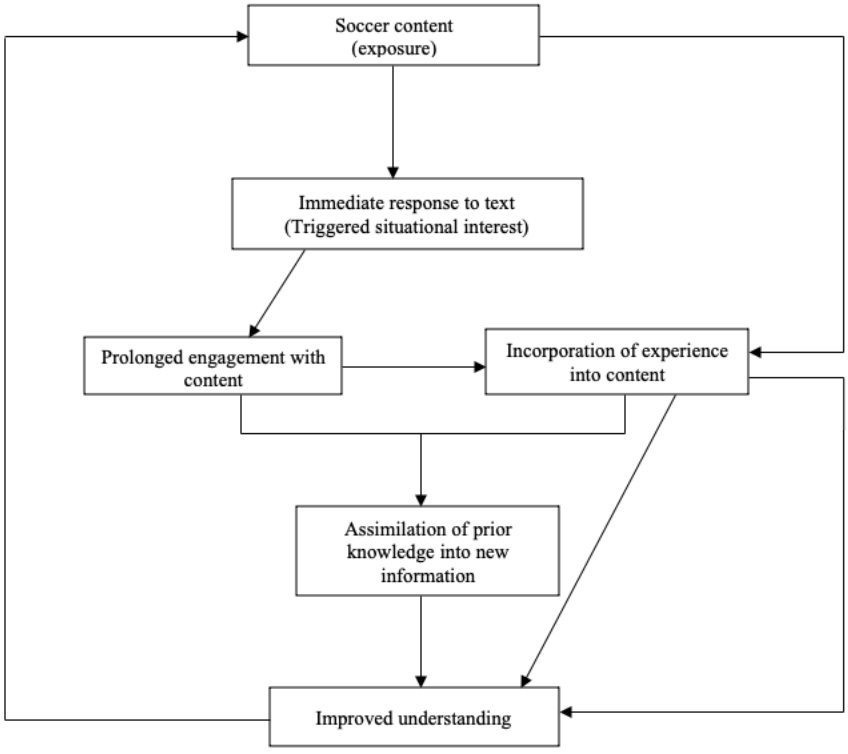
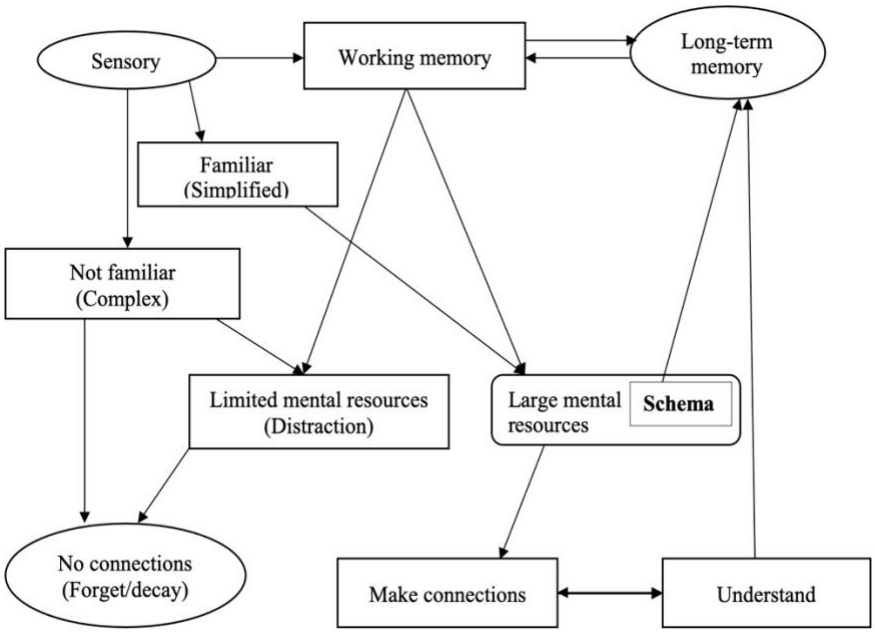


***Figure* 2** below shows Information processing: Why soccer content will lead to learning due to improved engagement



3.3.1 Elementary school students

Participants

6 students (n = 6) with a mean age (M = 12) with a range of 11-13, including boys (n = 3) and girls (n = 3) completed this research activity. They are all in the Worcester school district and attend the ACE afterschool Saturday program. All the participants are either immigrants or refugee from Africa. Participants are proficient in the English language, although they are all English learners, and for some, English is their third language.

Materials

Research materials included paper glues, cardboard, color sheets, pencils, rulers, and cardboard shapes 2-dimensional figures.

***Procedure* 1**: Control Condition

Students completed the baseline (the control activity) during their regular Saturday lesson. Students learned about 2-dimensional shapes. The instructor drew a rectangular shape on the board and asked students how many times that could be equally divided. The instructor drew two perpendicular lines to divide the rectangular into four parts and asked what new shapes had been created. The instructor then drew two diagonal lines to create new shapes within the rectangle. One student came forward to further divide the rectangle into several shapes. Figure 3 shows the initial shape activities.

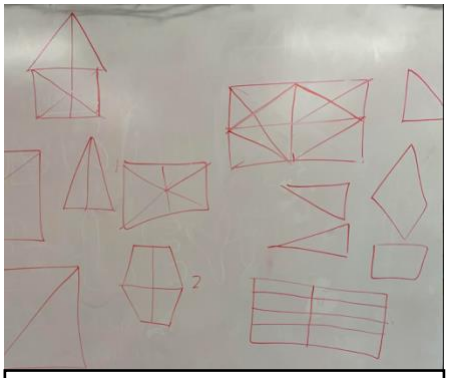


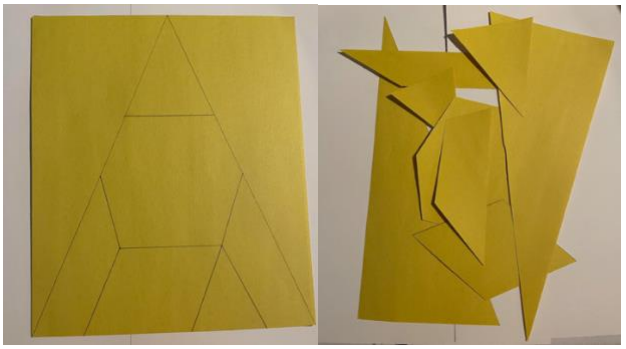
Fig. 3. The initial shapes activities

After these initial activities with the students, I gave the students three different types of shapes: hexagon, pentagon, and a triangle. The instructor then asked students – in as many as possible – fold the shapes into two equal halves. Students folded these shapes into many shapes as they could. Some of them did more than necessary but in all, they followed the instructions and folded the shapes.

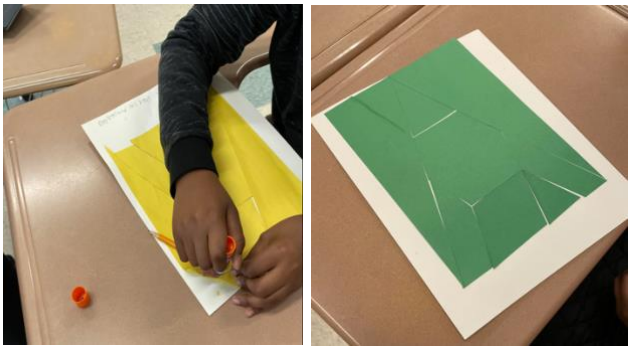
After the initial activities, the students voluntarily paired with each other, making 3 pairs. I handed out paper glues. Each group has two paper glues. I then gave them a cut-out rectangle to be stick together. Like the initial activity, the rectangle had been cut into different shapes. The laid-out shapes consisted of triangles (including right triangle and isosceles triangles), a hexagon, and trapezia. The students were then asked, using the clue, to put these pieces together on a white cardboard to make a rectangle.

Students' questions were answered. Students received all the materials they needed to complete the activities. The essential materials were the different shapes, the glues, and the white cardboards. Students selected their preferred colors. See below for the initial cut-outs and assembled pieces that formed the rectangles.

Figure 4 show initial shape and students made shape.



The picture on the left shows the shapes that were made from the rectangle and the one on the right shows the subsequent cut-outs



The picture on the left shows students working on the pieces and the one of the right shows a completed rectangular shape made from the pieces

Throughout the lesson, two observers rated the students' level of engagement and disengagement. The observers had rubrics to guide them, but they also had options to write a comment to explain their choice rating. These ratings were averaged at the end. (See Appendixes C for the engagement and disengagement scales that were used by the observers). On a 4-point scale (with 1 = most of the time and 4 = Never), the observers rated the students on indicators such as whether students asked lesson-related questions, whether they made agreeing gestures, and how often students interacted with their phones, etc.

At the end of the lesson, students completed four assessment questions. Students were given four different shapes and were asked to draw a line that could divide the shapes into equal halves. (See Appendix G for the assessment questions). Students then completed the 10-item interest survey after the assessment. On a 5-point Likert scale with smiley faces, students were asked to rate the level of interest regarding the lesson they had just completed. (See Appendix D for the interest survey). I chose a smiley face for the elementary school students as an accompanying explanation for the written statement. Different kinds of smiley faces were shown to the students to find out which one they understood two weeks prior to the actual study.

***Procedure* 2**: Experimental condition

This was completed one week after the initial lesson. Participants included 6 students with one absentee from the prior study and a new substitute. The students included both boys (n = 3) and girls (n = 3). The participants had an average age of 12 with a range of 11-13.

This lesson was the experimental treatment. After the initial introduction, I gave a brief overview of what they had done a week prior and explained that this is the second and concluding part of the activity. The students voluntarily paired with their peers as they had done the prior week.

I distributed the lesson materials to the students and explained that they are to assemble the piece of paper together on the cardboard. They are then to glue the pieces together after they had arranged the pieces into a model soccer field. The cut-outs came in different colors and students had the choice to combine different colors. One group combined different colors to make their model soccer field.

The figure below shows the initial soccer model, the pieces the students had to glue together and their end products.

3.3.2 High School Students

Methodology

Participants

8 students (n = 8) with a mean age of (M = 16) participated in this research activity. Participants included boys (n = 6) and girls (n = 2) who attend the ACE Saturday after school program. All the participants are students in the Worcester school district. They are either immigrants or refugees from African. Although still English learners, all the participants are proficient in English, i.e., they understand both the written and spoken language.

Materials

Research materials included Cardboard papers, graph sheets, paper glue, color papers, ruler, pencils, markers/pens, clippers, and office pins. There were engagement rubrics for observers (see appendix C), interest survey questions (see appendix D), and assessment questions (see appendices E and F). The survey questionnaires are adapted from Mitchell (1993) and Luo et al (2019). The number has been reduced due to time constraints and the contents have been

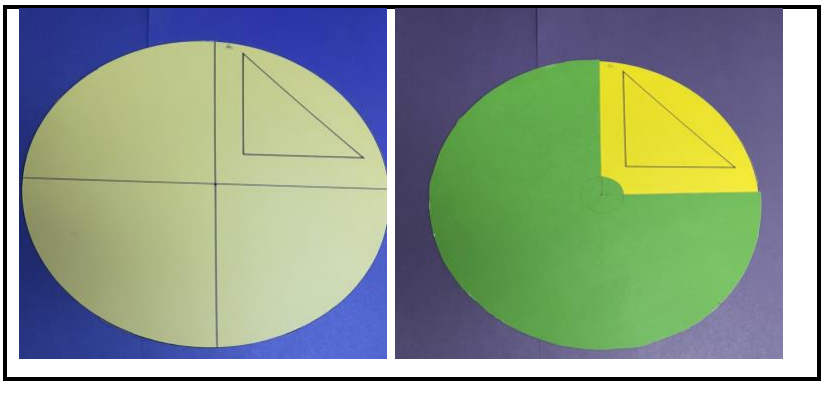
modified to avoid socially desirable responses. The interest survey was implicitly divided into two. The first section from 1-4 asked students to rate their perception of the activities and the next section from 5-10 asked them to rate how much they value math in their lives.

***Procedure* 1**: Control Condition

First, I introduced the concept of transformation to the students. I then gave a brief overview of the different topics of transformation such as reflection, rotation, dilation, translation, etc. and introduced the concept of rotation, which was the topic of the first day. I drew two perpendicular lines on the white board. I placed a model right triangle made with a cardboard in the first quadrant and moved it along the different quadrants. After this demonstration, I explained to the students how the position of the right triangle changed from one quadrant to the other as it moved.

Students voluntarily paired with each other in groups of two, making 4 pairs. I distributed the materials for the lessons which included carboards, rulers, pencils, paper glues, clippers, color papers, etc. were given to the groups. Students were first instructed to draw two perpendicular lines on the first spherical cardboard then place the second cardboard that was also spherical but with a cutout on one side of the perpendicular lines. Students were then to punch a hole through the middle using an office pin. This hole was going to be penetrated with the pin to hold it together to make it spine.

The figure below shows the concept.



Students placed the right triangle in a quadrant of their choice then moved it along quadrants. They then sketched the position of the right triangle in each quadrant as they moved it along from one quadrant to another.

Throughout the lesson, two observers rated the students' level of engagement and disengagement. On a 4-point scale, the observers rated students on indicators such as how often they interacted with their devices, how often they used the bathroom, and whether they asked lesson-relevant questions.

When the students had completed their products, they answered 4 assessment questions. (See Appendix E for the assessment questions). The students then completed a 10-item interest survey on a 5-point Likert scale. The students rated the relevance of the activities and the value of math in their lives. I read the survey out loud for the students. However, it was completed anonymously.

***Procedure* 2**: Experimental condition

I reminded the students about the prior activity on rotation, then explained that reflection is another form of transformation. It was, however, emphasized that, in a reflection, the mirror image of the original object is created. I drew a sketch of a soccer field on the board and pointed out how one side of the soccer field is a mirror image of the other side. The goal posts, for example, were pointed out. I explained this can be understood as an example of reflection.

The students voluntarily paired with each other, making 4 pairs. I distributed the research materials which included cut out soccer field model, paper glues, rectangular cardboard, and pencils to the students. Students were first instructed to assemble the pieces of shapes together on their cardboard. After assembly, and noticing the shape of the soccer field, they would then glue the pieces as assembled, lifting one after the other until all are put together to create the model soccer field. Students were instructed to write the names of their favorite players on the field in a 4-4-2 formation.

Like the control condition, the two observers rated the level of students' engagement and disengagement using the prepared rubrics. When students had been completed their final products, they answered 4 assessment questions. (See appendix F). Students then completed the 10-item interest survey on a 4-point scale as they had done after the control condition. I read it out loud for the students. However, it was completed anonymously.

Chapter 4: RESULTS

This thesis answered three questions. First, can participant observation research elucidate the learning needs of immigrant and refugee children? Second, can project-based learning improve students' engagement in STEM? And third, does culturally relevant content engage immigrant and refugee students in learning? In this chapter, I will present the findings from these research methods to answer the questions above. The chapter is presented according to the research questions in chapter 3.

4.1 Can Participant Observation Research Elucidate the Learning Needs of Immigrant and Refugee Children?

Homework Support

Students at ACE receive one-to-one homework support. They also receive tutoring on other subjects. The program has divided the homework tutoring session into three classes (according to age and grade). Each class has an assigned permanent support, usually an ACE staff member. Aside from these permanent staff, college students also volunteer and assist these students with their homework. Math is the number one subject that students mostly ask for support. The permanent staff know the level of support most of the students require and would usually assign volunteers to students after consulting with the volunteers about areas they feel comfortable assisting students with. Some of the students have built relationships with staff and regular volunteers and would always work with these volunteers and staff.

Sometimes, students are paired with volunteers who cannot provide the support they need. In one instance, one volunteer, who was asked to help a student complete her math homework, sincerely admitted that “this math is hard. It’s nothing like I have ever done before”. If a college student, finally admits that math is hard, it further depresses these students who are already struggling with math and science. And it reinforces their belief that math is hard and there is nothing they can do about it.

Generally, most students would prefer that volunteers and staff complete their homework for them without their input. The difficult task was balancing the need to help them learn and understand the questions while learning when to take a lead in completing the work. Most of the students preferred staff and volunteers who will take the lead. As they get good grades on their

homework, they get lower grades on tests at school because they did not take the time to understand the content of their homework. Through productive struggle, students can be guided to complete their homework by taking the lead. This process would subsequently improve their understanding. This is however not an easy task especially if the volunteer or staff is unable to engage the student.

Through regular reminders of the importance of getting involved in their homework, two students I regularly worked with finally got it. I will use "Matt" and "John" for them. Matt was an 8th grader and John was a 9th grader. After struggling (with guided support) to complete his homework, Matt had two questions wrong. I asked what he was going to do, and he said he was going to tell his teacher to reopen the homework for him the next day since it was not yet due. Going back to the teacher for clarification or assistance was not a common idea or practice among the students at ACE. Similarly, John, the 9th grader came back to me to demonstrate what I had discussed with him just two days ago. He had worked on a subject himself and he wanted to show me that he now understands the concepts.

Students' Attitudes Towards Online Learning Systems

Most of the children have their personal computers and they bring them to the program. ACE has Chromebook for those who need them. There is reliable and stable internet access at the program, with occasional but rare internet interruptions. Most of the students' homework is completed online. They usually log in to their Google Classroom accounts and complete their homework.

Most online systems are equipped with assistance to help students complete their work. There are embedded worked examples, scaffolding questions, and sometimes, embedded videos to show step-by-step processes for solving similar questions. Feedback is an important feature of online learning systems and most of the systems these students use provide immediate feedback to guide students' learning.

It was observed that none of these features have any positive influence on the students' attitudes on learning. While most of the students complete their homework on Google Classroom, they usually log in, access their homework, complete, submit, and shut down the Chromebook. The Chromebooks seem to have no use to most of them other than homework completion. Meanwhile, these learning platforms have been equipped with anything imaginable

to help the children learn. Other than doing homework, a few used it to play games or watched videos on YouTube. This is one I termed “one dimensional technology”. I asked several of these students about why they do not use those features and the common answer they gave was “nothing”. Some of them have no interest in the subject to begin with. With the lack of an interactive medium, there is nothing to engage them in their online learning endeavors.

4.2 Can Project-based Learning Improve Students' Engagement in STEM?

To answer this question, two of the several project-based lessons were reported in this section. In the first lesson, elementary school students learned basic arithmetic using a story of Pele, the Brazilian soccer player. After the lesson, one student came back to the classroom and while still surprised at how the class went, asked: "isn't this supposed to be a STEM class", I responded, “yes”. “Then why did we have to read a story", the students continued. I then reminded her that the arithmetic they had completed when they calculated they goal difference between Pele and Arthur Friedenreich, the soccer field they had sketched, the length and width they had labeled, and the distanced they had measured to identify the length and width of the sketched soccer field were all mathematics. The student nodded and went away.

The notes from the NIOST observer provides valuable lessons. Among the many things that were observed (see Appendix I), the observer noted that “STEM activity is led by very experienced classroom manager. Youth respond to behavior guidance and expectations. All participate in activity and stay focused. There is clear noticeable progress through the goals of the activity”. Thus, project-based learning gave lesson directions and provided guidance for the students. The direction and focus this PBL lesson provided sustained their attention throughout the lesson and improved their participation in lesson activities.

In addition to the students’ behaviors, the observer also noted how staff maintained and engaged the students in the lesson. For example, it was noted that “Staff are all actively engaged with youth and regularly ask open-ended questions to prompt thinking. Staff are energetic and provide youth assistance whenever asked. Staff are generally very flexible in their management of youth and redirect respectfully when needed to guide challenging behavior. Youth are given small roles (responsibility) in activities including taking turns reading aloud, answering math problems, expressing their opinions. Two activities devote a small amount of time to asking

youth to reflect on what they learned during the session (emphasis is on take-a-way points versus structure/nature of activity or shaping".

4.3 Does Culturally Relevant Content Engage Immigrant and Refugee Students in Learning?

Elementary school Students

This study set out to examine how culturally relevant content would engage ACE's students in learning compared to non-culturally relevant content. Culturally relevant content is defined as any piece of information the students have a practical understanding because of its prevalence and relevance in their lives. These included things they are familiar with either in their home countries or in their current household in the US. For ACE students, soccer was chosen because of its importance at the program. The students play soccer every Saturday and left alone, that is the only thing most of them would do when they attend the Saturday program.

I hypothesized that students would score higher on assessment test after the soccer lesson compared to the no soccer content lesson. It was also hypothesized that students will have improved interest and engagement during the soccer lesson compared to the no soccer lesson.

As hypothesized, students' engagement level during the soccer content was higher ($M = 2.4$, $SD = .53$) compared to the control condition ($M = 1.94$, $SD = .98$), $t(8) = -2.27$, $p = .053$. This shows a statistically significant difference in students' engagement between the control condition and experimental condition. Interestingly, however, the engagement levels did not translate into test scores. Control condition assessment ($M = .67$, $SD = .82$) was higher compared to the assessment scores after the experimental condition ($M = .0$, $SD = .0$). This difference was not statistically significant, $t(5) = 2.0$, $p = .10$. This can be attributed to the higher disengagement score vis a vis the higher engagement score, especially in the no soccer content lesson.

Students reported higher interest during the soccer content activities ($M = 3.92$, $SD = .54$) compared to the control activity ($M = 3.82$, $SD = .45$), $t(5) = -.75$, $p = .49$. The interest survey had two sections: the first section measured students' perception about the research activity and the second section measured how students value mathematics in general.

Table showing students responds reported interest pertaining to the research activities.

Activity-specific Interest		
	Mean (*M*)	Standard Deviation (*SD*)
Control Condition	3.4	.64
Experimental Condition	3.6	.63

The table above shows that on the 5-point Likert scale with 1 = strongly disagree and 5 = strongly agree, students reported that they were not sure whether the information/activities in the no soccer content lesson would be used in real life, whether the contents were related to life problems, or would be needed in their lives. However, in the experimental condition (soccer content lesson), they agreed (although not quite strongly) that what they have learned in the class would be used in real life, were related to life problems, is important, and would be needed. Despite this increase in mean, the results were not statistically significant.

However, there was a strong relationship between the soccer content and students reported interest, $r(6) = .93$, $p = .007$. This relationship does not imply that the content caused the increase in students' interest, but it does, however, suggest further investigation to determine this relationship.

Similarly, the table below shows that students had a positive outlook about math in both the control activity and the experimental activity. In both conditions, the students agreed that the knowledge of math is useful in their daily lives and for their future development because knowledge in math makes life easier.

Table showing how students value math

General Interest in Math		
	Mean (*M*)	Standard Deviation (*SD*)
Control Condition	4.1	.52
Experimental Condition	4.2	.67

Two observers rated students' engagement and disengagement on a 4-point scale during the research activities. The two ratings were averaged. The observers had rubrics pertaining to

students' reactions during the lessons. A few examples of the rubrics were: were students interacting with their electronic devices or not, did the students ask lesson-relevant questions, how many times did students use the bathroom, etc. The table below shows the observer ratings.

Table showing observer rated students' engagement

	Engagement			Disengagement	
	M	SD		M	SD
Control condition	1.94	.98		3.0	.61
Experimental condition	2.44	.53		3.1	.60

It was shown that the students were highly engaged in the experimental condition than in the control condition, $t(8) = -2.27$, $p = .05$. In both cases, the observers rated that students engaged in those behaviors some of the time. The no soccer content was not as quite strong as the soccer content. This is further evident with the SD of the no soccer condition. Looking at the table, it can also be observed that the students were disengaged at similar levels in both the control and experimental conditions. Also, with a lower engagement in the control condition comes with a higher disengagement. Similarly, with improved engagement at the experimental condition comes with overstimulation resulting in increased disengagement, $t(8) = -2.74$, $p = .03$. For example, as students asked relevant questions because the content was relatable, so were they interacting with their mobile phones or playfully hitting and talking with their peers.

High school Students

To test the efficacy of culturally relevant content in improving students' engagement in math learning, students were exposed to two different treatments. One has no soccer content, and the other had soccer content, which was classified as a culturally relevant because of its practical meaning in the lives of the students. The table below shows students' level of engagement and disengagement as rated by two observers on a 4-point engagement scale, with 4 = most of the time and 1 = never.

	Engagement			Disengagement	
	M	SD		M	SD
Control condition	2.97	.72		2.61	.47
Experimental condition	2.22	.71		2.50	.94

The table shows that, in the no soccer condition (i.e., no culturally relevant content), students were engaged and less disengaged and that difference was significant, $t(8) = 2.93$, $p = .02$. This also showed that with a higher level of engagement, so was a recorded higher level of disengagement. In the soccer content condition, however, students were more disengaged in the research activities than were engaged. Also, instead of an improved engagement from control condition to the experimental condition, the opposite was observed. The difference in means of engagement and disengagement shows that the students were as engaged as they were disengaged.

After the research activities, the students completed a 10-item survey on how and whether they were interested. The first section of the survey numbered 1 to 4 asked students to rate the level of interest on the activity and the second section numbered 6 to 10 asked students to rate how much they value math in their lives.

The table below summarizes the students' reported interest for the research activities and their general math interest.

Table showing students reported interest in the activity and in math

	Activity-specific Interest rating			General Interest in Math rating	
	M	SD		M	SD
No soccer content	2.00	.34		1.90	.34
Soccer content	2.04	.53		1.80	.51

The table above shows that on a 4-point Likert scale, with 1 (strongly agree) and 4 (strongly disagree), students disagreed with the relevance of the activities in their lives as well as the value of math in their lives. This disagreement was reported in both soccer and no soccer conditions.

The general interest and the value they attached to math in their lives remained somewhat constant from one condition to another. Students' rated interest after the soccer content ($M = 1.93$, $SD = .34$) was almost the same as the soccer content interest rating ($M = 1.88$, $SD = .51$), $t(7) = .23$, $p = .82$ indicating a no statistical difference in the two conditions after the intervention.

The assessment test also gives insights into how students understood the contents of the control and experimental conditions. Students were assessed immediately after the control activities and a follow up assessment a week later. However, students received only immediate assessment after the experimental condition and no delayed assessment due to program scheduling. There was an average score of ($M = 1.50$, $SD = .55$) for the immediate assessment. Students' performance reduced on the delayed assessment ($M = 1.14$, $SD = .69$), $t(6) = 1.00$, $p = .36$. On the other hand, students obtained higher assessment scores after the soccer content lesson compared to assessment scores after no soccer content lesson ($M = 2.14$, $SD = .69$), $t(6) = .02$, $p = .05$.

Chapter 5: CONCLUSIONS

In this concluding chapter, I will present the general discussion from the three research questions. Firstly, key findings from the thesis are summarized. These summaries provide a snapshot of the research findings. Secondly, the findings from these studies are elaborated and discussed. The general discussion is followed by the study's limitations that were found during the research process. The limitations are followed by recommendations for future research.

5.1 SUMMARY OF KEY FINDINGS

Participant observation research can provide insights that experimental designs cannot, especially when dealing with educational research in a diverse environment. Despite its limitations, when done well and the information meticulously recorded, the data from participant observation research can generate new research questions while adding more insights into previous findings.

Project-based learning can improve students' engagement in learning. The hands-on activities can trigger students' interest, foster collaboration, and promote the 21st century skills students need to succeed in school and obtain meaningful employments after school. Project-based learning can demystify students' perceptions about subjects they deem difficult by making things relevant and concrete during lesson presentations.

Culturally relevant pedagogy has been shown to improve students' engagement in learning. This engagement, however, does not necessarily translate into immediate performance. Since learning can be latent, i.e., not manifestly apparent, different forms of assessments other than paper and pencil might be needed to further investigate this phenomenon.

Immigrant and refugee children have varied learning and psychological needs. These needs can be met in various avenues. School-based resources can be invaluable support for these children. However, since a lot more is needed to meet the needs of these children, and a lot of time is spent outside of school, a well-structured out-of-school-time, as it has been shown in this study, can provide an engaging learning environment for immigrant and refugee children. Any out-of-school-time program for immigrant and refugee children must be tailored to their needs, must have culturally rich activities, and must provide project-based learning opportunities to stimulate their interest in learning while engaging them.

5.2 GENERAL DISCUSSION

To better understand the learning needs of immigrant and refugee children, and to support them, three research approaches were used. Firstly, I learned a lot about the children: their names, how long they had lived in the US, their country of origin, the names of their schools, their favorite and disliked classes, and what they would want to do when they attend the afterschool program. Most of these questions could have been answered with a simple questionnaire administered in a few hours to all the participating students at ACE, but I chose the long-winding way: I learned these by been part of them and observing their lives at the program. Through this method, I was able to associate several other qualities to the information I obtained. I could have learned their name alright but would not have known its meaning; would have learned about their country of origin but would not have learned that some of them have lived in different countries on the African continent before they finally arrived in the US. I would not have learned that they were born on a country other than the home country of their parents, etc.

Through the participant observation, I obtained insight that is not apparent during regular school time or a regular classroom setting where rules and expectations are different and an apparent balance of power between teacher and students. I observed students in a natural setting with little opportunity to pretend. As a researcher, I could compare what students say to what they do. I got to know them better and they felt secured talking with me without any reservation. Students are mostly willing to talk with "authority" figures. However, they talk from their hearts when there is an established relationship, and that is what this method of research affords an investigator. Although a lot was learned from this research including how relationship between staff and students improve students' attendance, the recent gradual transitioning from in person learning to online learning makes students attitudes towards educational technologies worth discussing.

Students online learning behaviors have been thoroughly investigated and new systems continue to be built to support students. Whereas, students' online activities provide a wealth of information about their learning habits and preferences, a lot is lost without a physical engagement and direct observation of students' attitudes, reactions, and perceptions. This side of students which is necessary for a holistic understanding of how to use educational technologies and how best to support them utilize all its features.

I observed that online systems can improve the education system as others have found (e.g., Heffernan & Heffernan, 2014). However, what is lost in most research pertaining to online learning system is that, for a successful implementation, an emphasis on the human support is as important as the features these systems afford. Whereas technology can improve efficiency in many sectors of the society, a lot more is required for technologies to assist in the education of the youth. Muilenburg and Berge (2005) indicated that a complete system comprising the school administration, network of students' social interaction, required (and clearly defined) academic skills, appropriate technical skills, learner motivation, time and support for studies, cost and access to the Internet, and technical support must be discussed and provided. This assessment however was for college students. K-12 students might need a more robust system (including human and technological) for a successful online learning.

Another question that has not been thoroughly explored regarding online learning is whether it works for all students. Alhumaid (2019) found that classroom technologies such as computers are "deteriorating students' competencies of reading and writing, dehumanizing educational environments, distorting social interactions between teachers and students and isolating individuals when using technology". Similarly, Lineberger (2016) also found that, no matter the form of online learning, students report isolation, unengaging, excessive text instead of hands-on activities, and lack of interaction with teachers/instructors and peers. For immigrant and refugee students who are still transitioning into the US society, catching up on their educational loses, having parents who are sometimes not proficient in English and with little former education, online learning might be retrogressive with unintended consequences.

The participant observation method of research is by no means the preferred methodology for most educational researchers. It takes time. I spent 8 months and there are still a lot yet to be learned from these students. Participating in activities while taking notes or trying to capture important moments of the visit is an arduous activity. However, for a nuanced understanding of learning how best to support a diverse group of students and to learn their capabilities and the level of support they might need, participants observation is the ideal research method.

This method added human faces to numbers and signifiers I would have otherwise obtained so easily. Their English language proficiency, for example, could have been rated but been part of them taught me that most the children are proficient in multiple languages as well. Their language proficiency could therefore not be described as deficient as I might have concluded had

I used a different methodology. Through the participant observation method, I did not learn only how students read but how they read in the various subjects. For example, reading in English was different from math or history, etc. with this understanding, any intervention would not only look at reading broadly but reading in specific subject areas. This further prompted more questions about why students have ease reading in one subject and not the other. In this situation, homework support, say, in math will not be focused on helping the student answer the questions but first and foremost, find out whether the student can read and understand the questions.

The first project-based lesson was planned after about two months working with the students during the after-school tutoring and homework support. The lesson was taught on the third week of the Saturday program. At this time, I had learned a great deal about the students' perception about school, their interest in learning, and their attitude towards mathematics, a subject many of the students disliked. The purpose of this lesson was an attempt to identify different but effective ways to support the students learn math. The soccer content was purposefully selected because soccer is the most popular sport at the program. Soccer is played every Saturday and most of the students are either familiar with soccer at the program or from their home countries. Making math a familiar sport was aimed at demystifying STEM as an elitist subject, a prevalent mood among most of the students at the program and to improve their communication skills through reading and listening to their peers during the lesson.

One of the PBL lessons was observed by an observer from the National Institute of Out of School Time (NIOST). This observer's notes provided valuable information about how the class went and the needed changes that could be made to improve the lesson to effectively engage the students in learning. The observer noted that the "youth are typically working individually or as a whole class versus opportunity to work in pairs/in small groups/collaboratively". This influenced future lessons as subsequent lesson were designed to help students work in groups whenever that was possible. These PBL lessons were followed by experiments to determine how culturally relevant math content could engage the students in math learning.

To improve students' engagement in learning, this study set out to test the efficacy of employing culturally relevant content in learning. The study confirmed earlier studies that examined this question. It also added new insights into how best to engage students in learning without using overstimulating content. In an interesting finding, students were more engaged in the control condition than they were in the experimental condition. However, this engagement

did not necessarily translate into performance as measured with the immediate assessment test after the research activities. Although not highly engaged in the experimental condition like the control condition, students performed better on the assessment test in the experimental condition. This could be explained by the increased disengagement in the control condition. That is, when students are both engaged and disengaged, they tend to perform poorer. This is further confirmed by the delayed test that was administered a week later. Despite a lower assessment score on immediate test, students obtain still more lower score than previously obtained in the immediate test.

Results from the experiment show that whereas active learning through project-based alone can improve students' interest and engagement, albeit modestly, designing a project-based learning plan that is culturally relevant can make the lesson more meaningful and engaging. For the high school students, the practicality of the control treatment improved their interest and engagement. At the same time, they became rowdy and more disengaged. In the treatment condition when content was meaningful because of its cultural significance in their life, the level of their disengagement was reduced to compensate with their level of engagement. This was further evident in their performance which was measure in the immediate assessment test they completed. Similar results were found in the elementary school students' level of engagement during the no soccer content and the soccer content.

A soccer field was chosen for the treatment because is a familiar cultural phenomenon. They play soccer every morning before lesson begins and they end the day with soccer. They are familiar with the shape of the soccer field and could imagine how it would look like without much effort. For children who come from different African countries, soccer seemed one of the most common cultural objects that could elicit familiarity while facilitating their learning as they become more engaged in the activities.

As established by previous studies, incorporating culturally relevant contents in lesson improves students' engagement. Despite its elusive definition, the engagement and disengagement rubrics gave an insight into the levels of students' engagement during the lessons. The rubrics showed behaviors if exhibited, indicates whether students are mentally present or not during a lesson. This study, however, found that engagement does not necessarily translate into immediate desired performance. Although the students were more engaged during the experimental condition which incorporated culturally relevant content, students obtained lower

assessment scores compared to the control experiment where students were less engaged. This could also be explained that engaged content can be overstimulating and could be disruptive, thereby increasing students' disengagement.

The 10-item interest survey was divided into two sections. The first section numbered from 1 to 4 asked students to rate their perceptions of the research activities. The second section numbered from 5 to 10 asked students to rate the value of math in their lives. This dichotomy showed how students interest improved from the no soccer content condition to soccer content condition. It also showed how culturally relevant content could improve students' overall perception. As the result showed, it could but not quite strong. A larger sample size might clarify this phenomenon.

Students had a mixed interest rating from one condition to another. Whereas students had improved interest after the soccer content compared to the no soccer content, students reported a lower general interest in math after the soccer content compared to the no soccer content. It must be noted, however, that the difference in interest rating was not statistically significant and could not be attributed to the efficacy of the soccer content.

This contradicts previous work on the development of interest (Bergin, 2016). Whereas previous works have found that culturally relevant contents could improve interest, this study found otherwise. Whereas the intervention improved their engagement, the students reported that they disagree with the content's relevance in their lives as well as the importance of math in their lives. This is evident in how students' interest remains somewhat the same across conditions (whether soccer content or no soccer content) and across sections (whether on activity specific or general interest in math).

Despite their lack of interest and in math, they performed better on the soccer condition than they had in the no soccer condition. This shows that whereas interest is needed in the long term for reengagement in a content, engaging content can lead to immediate performance, albeit not retention as was seen in the delayed test in the no soccer content.

5.3 LIMITATIONS/RECOMMENDATIONS

The initial challenge for this project was identifying what a culturally relevant content for the ACE's students might be. Contrary to popular assumptions and due to ignorance, Africa is a content with diverse cultures. No two countries have the same culture and even in many

instances, diversity in cultures and preferences abound within the same country. Identifying one thing that have a practical meaning and usefulness to these diverse group of students was an arduous task. Nonetheless, soccer was an important sport and the most preferred sport for most of the students. I reached this conclusion during the initial stage of the project. I would often ask the students about their favorite sport and in most cases, soccer was their favorite sport.

Aside from the challenge with identifying what is culturally relevant to these diverse groups of children, was the sample size. Only 6 students participated in this study. This makes any attempt to generalize this finding difficult. However, this study did not rely on the test scores to determine whether the content had been effective or infective. Instead, it gathered data from students' observable attitudes during the research activities. The students also reported their perceptions about the study on a 10-item interest survey. These three sources of data, in addition to the prior study to understand their learning styles and needs through the participant observation method provide a wealth of information to tell a whole story.

The sample size and the lack of opportunity for a delayed assessment to measure learning retention were limitations of the study. I would have preferred as many students as possible. However, that was not possible in these circumstances. The overall students who attend the Saturday after school program are fewer and their number continue to reduce. Whereas the small sample size made it unfeasible to randomize the treatment, the between-subject design helped reduced variance and increased the statistical power. Also, my interactions with the students through the participant observation research gave me more insight into any possible interventions that could engage the students in learning.

Also, whereas I had only one chance for a delayed assessment and that yielded some insight about how much information the high school students retained after the control condition, I would have wished I had the opportunity for a follow assessment to measure how much the students retained after each condition, for both elementary and high school students.

From the above findings, insights, and recommendations, I would recommend a longitudinal study in these situations. This will give the researcher an ample time to measure the efficacy of the implemented interventions.

The findings also suggest an eclectic approach to doing educational research. Whereas testing the efficacy of interventions bring new insight and further theory, it is equally important to compare both qualitative and quantitative methods to first understand the phenomenon then use

the same mixed methods to test the efficacy of the intervention for a holistic approach. This therefore calls for not only a diversity of interventions for diverse students but for the diversity of educational research methods, and sometimes the combination of methods.

In the future, I would like to test new interventions with a longitudinal approach. I would follow some of these immigrant and refugee students over time to see how their academic performance improve as they attend these out of school programs that provide engaging learning resources.

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APPENDICES

Appendix A: this is the Pele lesson plan

Pele (Retrieved on Nov 7, 2021, from https://elevateabundance.com/peles-story/)

Pele is admired by many people as the best soccer player the world ever saw. But he worked hard to reach the highest echelons of soccer.

From Zero to Hero

Pele was born Edson Arantes Do Nascimento on 3 October 1940. He was poor, and he had to polish shoes to support his family. He demonstrated his interest for, and talent in soccer at a younger age and at 11-years old, caught the eye of prominent soccer player, Waldemar de Brito, a premier player of the nation. At 16-years old, he scored his first recognized goal against Corinthians FC.

The world recognized his skills and talents in 1958 when at 17-years old, Pele scored 6 goals with the Brazilian National team to win the world cup—their first ever. He was later declared a national treasure, barring him from playing for a non-Brazilian team or corporation. Pele was a swift runner, expert dribbler, powerful kicker, had an extraordinary command of the ball, and a master of head shots.

Out of the 1962 world cup due to severe injuries, he returned to win the 1970 world cup with Brazil—the third time for Brazil.

In all, Pele scored 1,280 goals, and is second only to Arthur Friedenreich, another Brazilian soccer player with 1,329 goals. On average, Pele scored one goal at every international game. He had 92 hat tricks and 97 international goals. This statistics places Pele at the top of his game, with the highest statistics ever.

Lessons:

Pele's story of zero to hero tells us that with hard work, dedication, and perseverance, we can become whoever we want to.

As a soccer player, Pele suffered multiple injuries and sometimes had to be carried out of the game in tears. But in all these cases, Pele bounced back—and he came back better than before.

Another lesson is that failure is part of the learning process. But Pele teaches us to try one more time whenever we fail. *"Success is no accident. It is hard work, perseverance, learning, studying, sacrifice and most of all, love of what you are doing or learning to do."*

Questions:

1. What the number of goals between Pele and the highest Brazilian scorer?

2. Sketch a soccer field and
3. Identify the length
4. Identify the width

Learning Objective:

1. Students will be able to read and summarize the passage in a sentence or two
2. Students will be able to subtract 1,280 goals from 1,329 goals to determine the difference
3. Sketch a soccer field
4. Identify the width of a soccer field
5. Identify the length of a soccer field

Appendix B: the lesson plan on the digestive system

On The Digestive System: 45 minutes (7 mins intro, 30m activities, 8m debrief)

Lesson 1 (Science journal for kids.org, 2020)

Objectives

a. Students will demonstrate the digestive process with the materials (banana, crackers, juice, water, cups, Ziplock, etc.)
b. Each student will participate in the class activity

Introductory questions to start the lesson

- What is your favorite food?
- What happens when we eat your food?
    - It goes into our mouth – then the stomach – intestines – and then we poop it out.
- The poop, however, looks different from the food you ate, so what happened to the food?
    - The poop is mushy
    - mixed up,
    - has a different color
    - smells different.
        - Where does all these differences come from? And where did the nutrients from the food go to?

Materials

Banana, crackers, one bottle of lemonade (as stomach acid), water, two zip lock plastic bags, a plain plastic container, one Styrofoam cup as a funnel (with cut off bottom), one Styrofoam cup as a plunger, 1 cut-off leg of tights/stockings (i.e., small intestine), gloves, scissors, a Styrofoam cup with a hole as large intestine

Procedure

1. Place the banana and crackers inside the Ziplock bag. Slowly add a little bit of water.
2. Squeeze out the air from the zip lock and zip it.
3. Smash the ingredients in the zip lock together using your hands until it is mixed, looking and feeling mushy.
4. Open the zip lock and add a little lemonade to the mushy food. Zip it and mash it again until it is all mixed.
5. Squeeze the mashed food to one side of the zip lock. Cut the other side of the zip lock, then empty it into the black stockings.
6. Hold the top of the stocking. Squeeze the food out of the stockings into the plain clean large zip lock. Cut the edge of the stockings with a pair of scissors and empty the solid left over in Styrofoam cup.
7. Cut the bottom of the Styrofoam with a pair of scissors and squeeze out the solid waste food into a plastic container.

Explanations

The banana and crackers are food we eat. The water we added to the banana and crackers before we squeezed served as the saliva the mixes with the food we chew in our mouth. The added lemonade is the acid that act on the food while in the stomach. Black stockings served as the small intestine and the large zip lock into which we squeezed the liquid out of the stockings is the large intestine. The Styrofoam cup is the rectum where undigested and solid waste gathers before we poop it out into the plastic container (toilet)

Appendix C: 1: the engagement rubrics

Rate these indicators using the 4-point scale in the middle; add explanation as needed.		
Indicator	**Check what applies**	**Explanation**
Were students' eyes focused on instructor?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students make agreeing gestures (e.g., nodding, smiling, or leaning forward) as the instructor speaks?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students take notes during the instructor's presentation?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students accurately write what the instructor asked them to do?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students ask activity relevant question(s) during group work?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students listen to peers during group discussion/work?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students make agreeing gestures (e.g., smiling, nodding, leaning forward) to their peers during group work/discussion?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students ask lesson relevant questions?	1. Most of the time 2. Some of the time 3. Seldom	

	4. Never	
How often did students answer instructor question(s)?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	

Appendix C: 2: disengagement rubrics

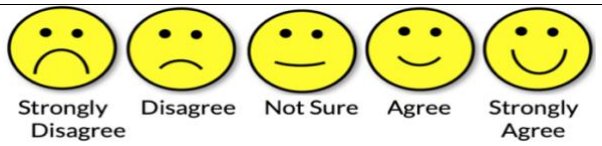
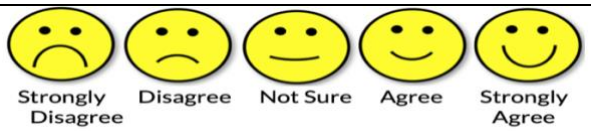
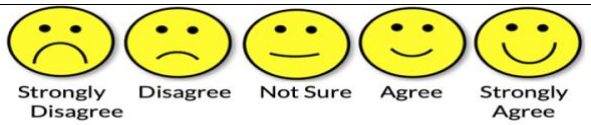
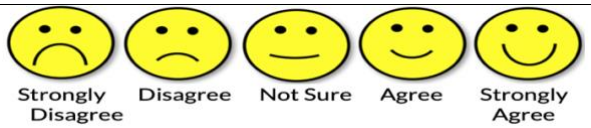
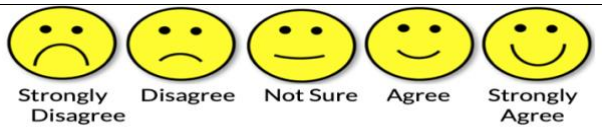
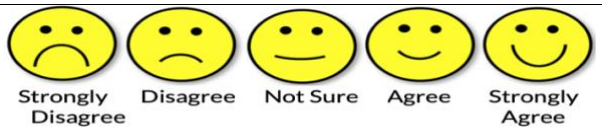
Rate these indicators using the 4-point scale in the middle; add explanation as needed.		
Indicator	**Check what applies**	**Explanation**
Did students take more than 5 minutes to settle down when they entered the classroom?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students leave the class before the lesson ended?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
How often did students use the bathroom?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students carelessly organize their lesson materials?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Were students actively working on something else other than lesson tasks?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
How often did students interact with their electronic devices (e.g., phone)?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students say something unrelated to the lesson?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	
Did students hit (playfully or not) other student(s)?	1. Most of the time 2. Some of the time 3. Seldom	

	4. Never	
Did students engage with other student(s) in conversation unrelated to the lesson?	1. Most of the time 2. Some of the time 3. Seldom 4. Never	

Appendix D: 1: interest survey for high school students

The things we learned in this class will be used in real life	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
The math problems in this class are more related to my life	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
I see the math we've learned as important in life	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
I will use the information in this class, so I need it.	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
A good mark in math course means a lot to me	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
Math is helpful for my career in the future	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
The knowledge of math makes my daily life easier	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
I find that the knowledge of math is useful in daily life	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
The knowledge of math is valuable for my future development	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree
I think that learning math is significant for my growth	1. Strongly agree 2. Agree 3. Disagree 4. Strongly disagree

Appendix D: 2: interest survey for elementary school students

What we learned in this class will be used in real life	
Math activities in this class were more related to life problems	
I see the math we've learned as important in life	
I will use the information in this class, so I need it.	
A good mark in math course means a lot to me	
Math is helpful for my career in the future	
The knowledge of math makes my daily life easier	
I find that the knowledge of math is useful in daily life	
The knowledge of math is valuable for my future development	
I think that learning math is significant for my growth	

Appendix E: rotation (control condition) lesson plan

ROTATION LESSON OBJECTIVE & MATERIALS

LESSON OJECTIVES:

1. students will make a spinner with a cardboard.
2. They will make a four quadrant with a right triangle in each quadrant.
3. Students will locate the position of a right triangle as it rotates from 90^0 through 270^0 (in a counter-clockwise direction)

LESSON MATERIALS

1. Cardboard papers
2. graph sheets
3. Paper glue
4. Color papers
5. Ruler
6. Pencils
7. Markers/pens
8. Clippers
9. Tape

KEY CONCEPTS

X-axis: horizontal
Y-axis: vertical, passes through the origin
Rotation: the movement of an object through the same angle about a fixed point. Unless otherwise stated, figures rotate counter-clockwise (positive movement). Rotation maps points of the plane to other points of the plane

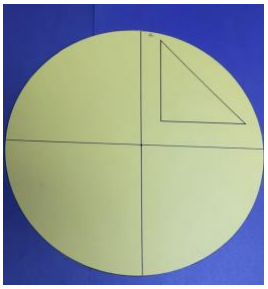
Rotation rule:
90^0 rotation: (X, Y) (-Y, X)
180^0 rotation: (X, Y) (-X, -Y)
270^0 rotation: (X, Y) (Y, -X)

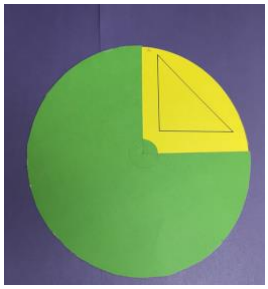
ROTATION LESSON ACTIVITIES

Activities

1. Students will make two spherical shapes of different colors with a cardboard
2. Students will draw two perpendicular lines to make a four quadrant
3. With a right triangle in hand, students will rotate is around and draw its new position in each quadrant
4. Placing another spherical shape in top, students will rotate from 90 through 270 to determine the position of of the right triangle in each quadrant

Rotation of a right triangle on a cardboard





INSTRUCTIONS FOR ROTATION LESSON

Overview of the activities

1. Overview of materials, process/activity guidelines
2. Group assignment
    1. Pairing up with a peer
    2. Groups of 3 if we have a large class
3. Distribution of activity materials to groups.
4. Students will two perpendicular lines on one of the two spherical shapes to make a four quadrant
5. Placing the right triangle in the first quadrant, students will rotate and draw the positions of the shape as it rotates from 90^0 through 270^0 quadrants

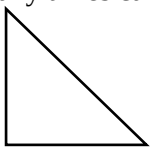
Rotation Immediate Assessment

NAME: _____ DATE: _____

1. Identify one object that rotates in the home

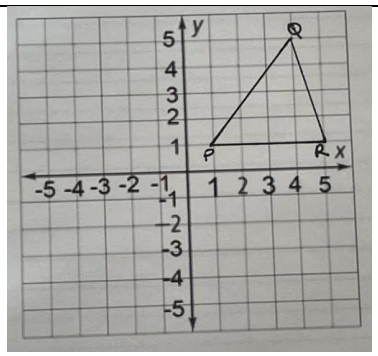
   Ans:

2. How many times can you equally fold this right triangle?



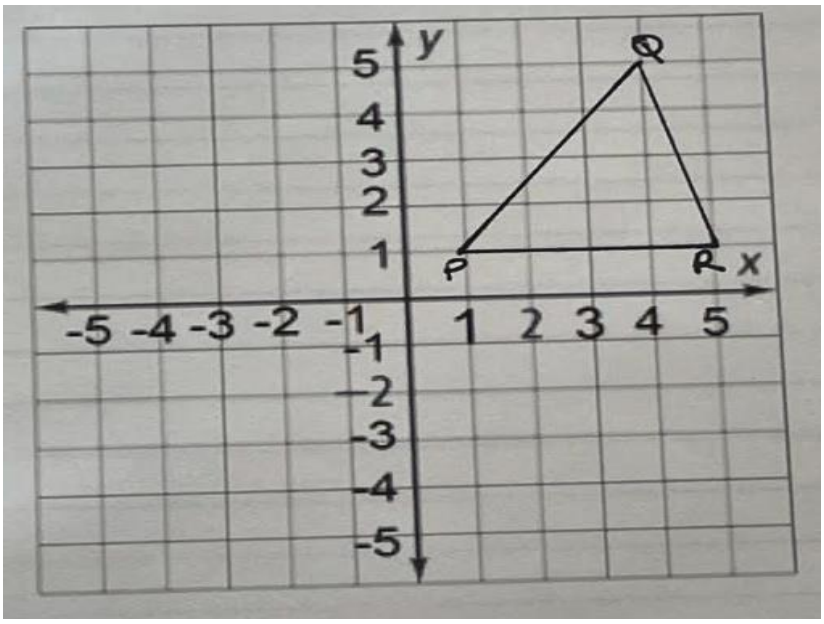
   Ans:

3. Using the graph, write the vertices of QPR



Ans:

4. Graph the image of figure QPR for a 90° rotation about the origin *0.*



Rotation Delayed Assessment

NAME: _____ DATE: _____

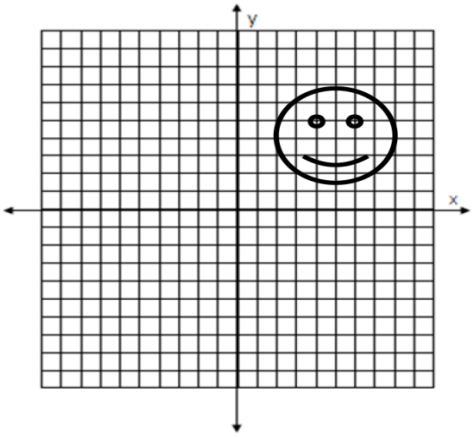
1. How many times can you equally fold a rectangle?

   Ans:

2. Write one example of an object that rotate

   Ans:

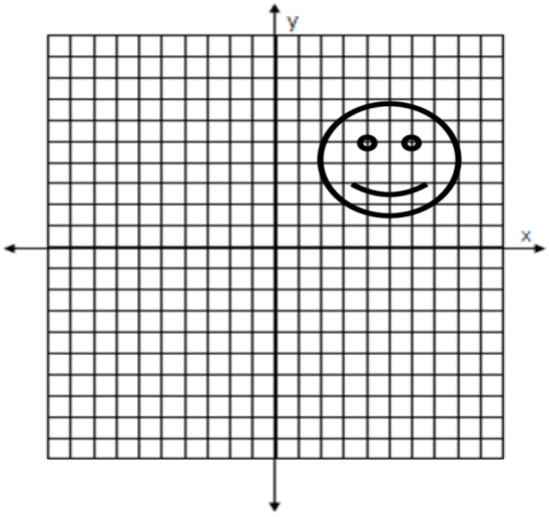
Use the graph to answer questions 3 and 4. Using a scale of 2 cm to 1 unite on both axes.



3. This is Marty. What are the coordinates of his right eye?

   Ans:

4. Rotate Marty at 90^0 and write the new coordinates for his right eye



Appendix F: reflection lesson plan

REFLECTION LESSON OBJECTIVE & MATERIALS

LESSON OJECTIVES:

1. Students will make a mode soccer field and a spinner using a cardboard.
2. Students will measure the length and width of a soccer field
3. Identify the mirror images on the soccer field

LESSON MATERIALS

1. Cardboard papers
2. graph sheets
3. Paper glue
4. Color papers
5. Ruler
6. Pencils
7. Markers/pens
8. Clippers
9. Tape

KEY CONCEPTS

X-axis: horizontal
Y-axis: vertical, passes through the origin

Reflection: The mirror image across a special line of symmetry. It is a flip over a line called line of reflection.
Reflection rule:
1. On X-axis: (X, Y)⟶(X, -Y)
2. On Y-axis: (X, Y)⟶(-X, Y)
3. Y = X: (X, Y) (Y, X)

Coordinates don't change when reflection is on the line of symmetry

REFLECTION LESSON ACTIVITIES

Reflection activities

1. Using a paper glue, students will stick a cut out model of a soccer field on a cardboard.
2. Students will measure and write the "length" and "width" of the soccer filed.
3. Students will write down "paired" shapes on the soccer field
4. In 4-4-2 position, students will place smiley faces with the names of their favorite soccer players at each position on the soccer field

Reflection activities and materials

INSTRUCTIONS FOR REFLECTION LESSON

Overview of the activities

1. Overview of materials, process/activity guidelines
2. Group assignment
    1. Pairing up with a peer
    2. Groups of 3 if we have a large class
3. Distribution of activity materials to groups.
4. Gluing the cut-out paper on the cardboard to make a model soccer field
5. Drawing (with the names of their favorite soccer player) of smiles faces on the field for a 4-4-2 formation
6. Measuring and writing the "length" and "width" of the soccer field

Reflection Immediate Assessment

NAME: _____ DATE: _____

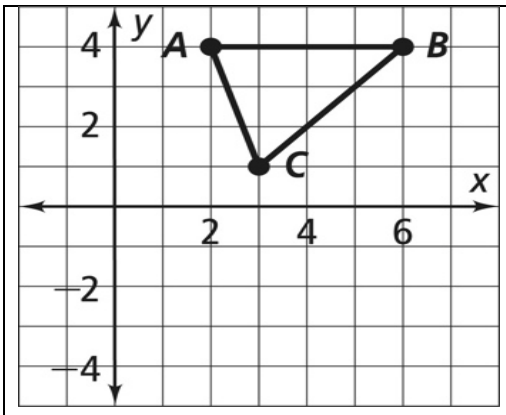
1. Using one side of the soccer field as original, identify 1 mirror images on the other side of the soccer field

Ans: _____

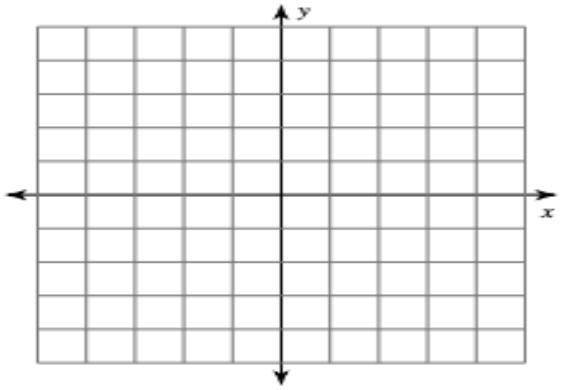
2. Write one example of reflection in the environment

Ans: _____

3. ΔABC has vertices at $A(2,4)$, $B(6,4)$, and $C(3, 1)$. What is the image of ΔABC reflected over the x-axis? Draw the figure on the graph



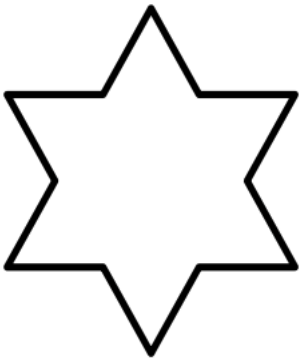
4. Δ*FGH* with vertices *F*(−1, 3), *G*(−5, 1), and *H*(−3, 5). What is the reflected image of Δ*FGH* across *y*–axis. Using a scale of 2 cm to 1 unite on both axes, draw the original and the reflected image in the graph below.

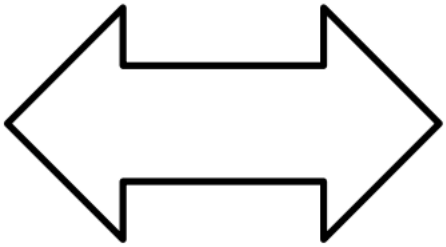


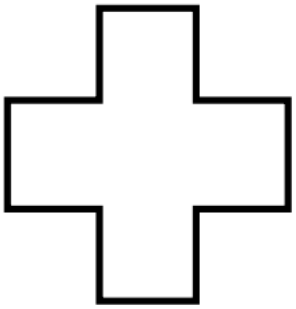
Appendix G 1: assessment 1 (control condition) for elementary school students

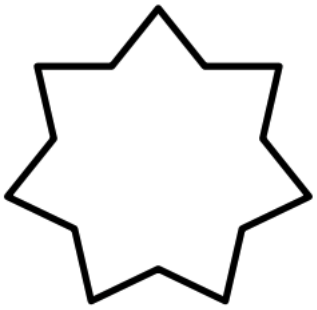
Name: _____ Date: _____

Draw a line that would divide the shapes in the box into two equal halves





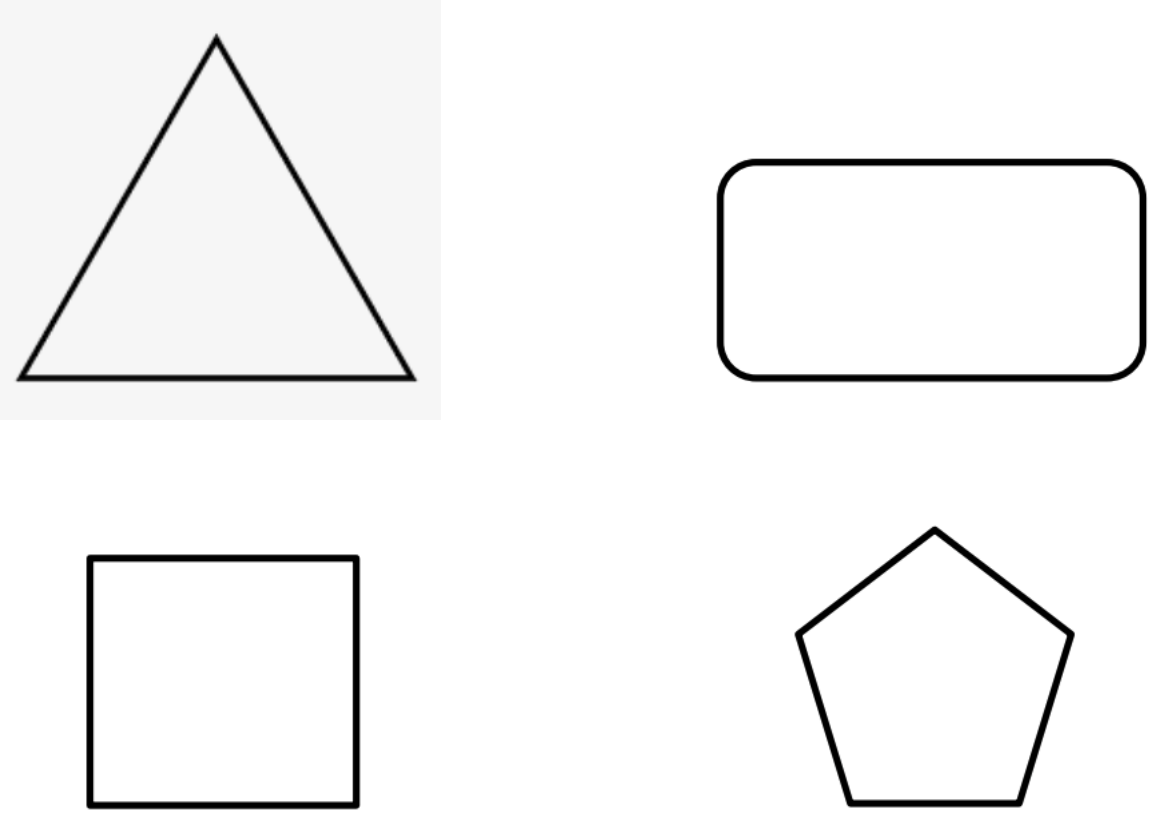




Appendix G2: assessment 2 (experimental condition) for the elementary school students

Name: _____ Date: _____

Draw a line that would divide the shapes in the box into two equal halves



Appendix: H

Woo-Labs Phase II
APT Observation
Summary - Fall 2021

Page 1

Q1 **Georgia Hall**

Observer Full Name

Q2 **African Community Education**

What site did you observe?

Date **11/06/2021**

Q3

When did you conduct your observation?

Q4

Brief description of activities observed

Observed arrival, transitions, informal time in gym, and 3 activities: ELL Middle School, STEM Middle School, EY Boys 1

Q5

Structure of program (e.g., scheduling, transitions, space)

Youth arrive to the program and have a choice for free play in gym or quiet work in section of cafeteria/general room. There are two activity periods in the morning followed by lunch and then one activity period and a choice period. Transitions are expected and handled (for the most part) smoothly by the youth - some youth sometimes need prodding to move to next activity or to go to where they are specifically scheduled. Program is located in adjacent

spaces so makes it easy for youth to travel to activities. Space is plentiful and there is flex space for homework help and computer work.

Q6

Organization and nature of activities in program

Program is organized and has close supervision. Two facilitators this day are instructing their classes for the first time. Both make considerable effort to lead and engage. More pre-planning with knowledgeable lead staff/coaching on activity planning may be helpful in situations like this going forward. Both facilitators struggled to engage and add rigor and challenge. One activity had to manage through interruptions from other youth in the classroom and ongoing addition of new youth to the class. Youth are typically working individually or as a whole class versus opportunity to work in pairs/in small groups/collaboratively. STEM class includes opportunity for group read-a-loud, but most STEM behaviors (Next Generation Science Standards) are missing.

Q7

Staff and their role in promoting youth engagement, stimulating thinking, and positively guiding youth behavior

Staff are all actively engaged with youth and regularly ask open-ended questions to prompt thinking. Staff are energetic and provide youth assistance whenever asked. Staff are generally very flexible in their management of youth and redirect respectfully when needed to guide challenging behavior. Youth are given small roles (responsibility) in activities including taking turns reading aloud, answering math problems, expressing their opinions. Two activities devote a small amount of time to asking youth to reflect on what they learned during the session (emphasis is on take-a-way points versus structure/nature of activity or shaping).

STEM activity is led by very experienced classroom manager. Youth respond to behavior guidance and expectations. All participate in activity and stay focused. There is clear noticeable progress through the goals of the activity.

Q8

Relationships between staff and youth

Youth and staff appear to have very friendly relationships. Youth show interest in staff, enjoy playing games with staff during gym free play, and act very respectfully towards staff. Staff are always professional with youth and listen attentively to youth. There is occasional praise and encouragement for youth.

Q9

Youth participation in activity time and peer relations between youth

Youth appear to get along well with each other. While the facilitation in some activities may break down, the youth still enjoy their time together and laugh and smile with each other. There is very little (serious) conflict observed during the structured activities or during free time in the gym. Youth cooperate well with each other sharing materials or equipment. Youth generally regulate their behavior well and follow program expectations.

Q10

Overall, what are some strengths of the program?

Diversity of staff and youth in the program.
Variety of spaces for program activities.
Friendly and caring staff.
Support from staff members for youth.

Q11

Overall, in what areas could improvements be made? Please include a minimum of 2 improvements.

It may be helpful to provide staff with easel and posterboard in classrooms to invite writing down group notes, equations, input from youth etc. The boards seem to be totally unutilized by the school and off limits to the program.

Having the strong baseline of classroom management skill present may create opportunities to invite more collaborative work between peers, youth shaping, peer-led presentations, hands-on, and project-based learning.

Coaching from experienced activity/curriculum leaders may help staff create more rigorous and engaging content.

There are many missed opportunities to add positive and encouraging remarks to youth - which may contribute to progress towards goals.