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Informal STEM Education for Underrepresented Racial Minorities: Students' Perceptions of the Imhotep's Legacy Academy After-school Programme

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by
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Abstract

This study explores students' perceptions of the Imhotep's Legacy Academy After-School Project (ILASP), an after-school STEM programme offered to Nova Scotian students of African descent. A sequential explanatory mixed-methods design was employed to understand students' beliefs about how the Imhotep's Legacy Academy (ILA) has impacted their views of STEM fields, their academic choices, and their career aspirations. First, data were collected in the quantitative phase of the study through online surveys and then a case study approach was used to collect data in the qualitative phase, which involved face-to-face interviews, and students' drawings. The findings indicated that the hands-on activities offered by the ILA reached a wide array of learners and helped them to have positive STEM experiences, nurturing their desires to pursue STEM academics and STEM careers.

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Ad Majorem Dei Gloriam

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Introduction

Statement of the problem

In Canada, education in science, technology, engineering and mathematics (STEM) and professions in STEM are held in high regard. Science, technology, engineering and mathematics permeate every aspect of Canadian society: From the healthcare system to the department store, STEM is prevalent. STEM not only, "drive[s] innovation, and ultimately economic prosperity," (NSERC, 2014), but it is at the forefront of improving our planet's well-being (European Union, 2014; United Nations, 2014). Although STEM fields are considered necessary in society and influential on our future, those who work in STEM fields are not representative of the population due to the fact that some minority (non-White) groups are underrepresented (Kendricks & Arment, 2011).

The repercussions of not having a representative population in STEM are that institutions related to STEM fields will also have an underrepresented racial minority population. This may not seem harmful at an initial glance, however, a critical social justice perspective on this situation reveals how it can perpetuate racism (Emdin, 2010b; Hodson, 2010; Tate, 2001). Racism within the Canadian context is defined as, White racial and or cultural prejudice and discrimination (often towards Indigenous people and African Canadians), intentionally or unintentionally supported by authority and institutional power (Higgins, 2014; Hodson, 2010). Based on this definition, when institutions, such as the education system, deny access or opportunities, whether consciously or not, to minorities, those institutions are exhibiting racism (Higgins, 2014; Hodson, 2010; Sensoy & DiAngelo, 2012). Consequently, STEM fields, which have an underrepresented African-Canadian, Caribbean, and Indigenous/First Nations population, can be seen as denying access to these populations in an influential field in society.

Education institutions are not exempt from this either as schools tend to reinforce social stratifications that are found within society (Collins & Solomos, 2010). Research shows that disparities exist between minority students' and White students' academic performance, academic engagement, and career aspirations in the fields of science, technology, engineering, and mathematics (BLAC Report, 1994; Eglash, Gilbert, Taylor, & Geier, 2013; Emdin, 2010a; Kendricks & Arment, 2011). Access to engaging in quality STEM educations, social mobility, and even economic opportunity rely on schools and are reinforced by schools (Collins & Solomos, 2010). The school systems' role in perpetuating social inequities in society cannot be overlooked. Schools are where students frame their ideas around race and identity (Levinson et. al, 1963; Emdin, 2010a). Thus, a cycle occurs in which disparities that exist in schools lead to disparities in society, which society then reflects back into the education system, where deficit notions are perpetuated for racial minorities, while White students are the model student (Esmonde & Caswell, 2010). As a result, this issue, which was once seen as a problem solely for educational researchers, is now a dilemma for economists and politicians (Emdin, 2011b). The ever growing attention given to the lack of minorities excelling in STEM courses and aspiring to STEM careers has sounded a siren for governments, scientists, equity researchers, teachers and parents from a variety of fields to address this problem (Emdin, 2011b).

In spite of the increased attention on this issue, action has not been taken, and when it has the transfer of knowledge and understanding of how students learn to praxis has been slow (Tate, 2001). In Nova Scotia, Dalhousie University's, Imhotep's Legacy Academy (ILA), a not-for-profit organization, offers culturally responsive STEM programming to Black youth, with the intention of breaking down the barriers that Black youth encounter in schools and especially in STEM fields (Imhotep's Legacy Academy, 2014). [1]The ILA is based on a university-community partnership, which focuses on bridging the achievement gap and improving students' academic success in STEM for junior high, high school, and post-secondary students of African heritage in Nova Scotia (Imhotep's Legacy Academy, 2014). The ILA offers programming to junior high students to impact their academic path early on, providing the necessary foundation for engagement with STEM subjects, countering the systemic barriers African Nova Scotians face in school, and promoting further STEM involvement throughout high school and post-secondary. The Imhotep's Legacy Academy combines STEM learning projects, leadership development activities, and tutoring support, with cultural lessons to redress the curricular issues, pedagogical issues, and societal issues that prevent African Nova Scotian learners from succeeding in STEM. The objectives of this programme are that: African Nova Scotian youth would have an increased awareness of STEM through the ILA's use of culturally responsive pedagogy that supplements what the students are being taught in school; that African Nova Scotians' eventual enrolment in post-secondary STEM programmes would increase; and that the representation of African Canadians in STEM professions would also increase (Imhotep's Legacy Academy, 2014).

Since the programme's inception a decade ago, it has expanded to five sites across Nova Scotia with two sites in Halifax, one in Cape Breton, another in Antigonish, and one in Truro (Imhotep's Legacy Academy, 2014). The programme is currently sponsored by the following agencies: the African Canadian Services Division of Nova Scotia, the Black Business Initiative, African Nova Scotian Affairs, the Africentric Learning Institute, the department of Economic and Rural Development and Tourism, NSERC, Dalhousie University, and TD Canada Trust

[1] A detailed description of the ILA's programmes can be found in Appendix A.

(Imhotep's Legacy Academy, 2014). The programme's sponsorship, longevity, and expansion are indicative of its support. Yet, these factors are not sufficient to provide evidence that the programme has met its objectives as they do not relate to students' learning. Thus, the focus of this research project is to provide an external evaluation of the ILA after-school programme to determine how it has influenced its participants' perceptions of STEM, as well as, their perceptions of STEM academics and STEM careers in particular. Feedback will be provided to the ILA, in order to help the ILA recognize how well it is meeting its objectives and to help the ILA determine what changes may need to occur to continue to tackle the issue of underrepresentation of African Nova Scotians in STEM fields.

Science, Technology, Engineering, and Mathematics?

The acronym STEM is used to abbreviate science, technology, engineering, and mathematics and is apparent throughout various levels of academia, from curriculum documents, to the formal and non-formal classroom. In spite of this, the STEM acronym leaves much to be desired regarding *what is STEM education*. In the 2014, Nova Scotia, *Learning Outcome Framework* for students in grades 7-9, the term STEM appears thrice and is not expounded beyond "Science, Technology, Engineering, and Math" (p. 109). For educational researchers STEM education is more complex, involving more than the tutelage of one in science, technology, engineering or math.

STEM education is an integrated pedagogical approach involving the amalgamation of at least 2 of the STEM subjects; science, technology, engineering, and mathematics (Brown et al., 2011; Gomez & Albrecht, 2014; Roberts, 2013). The fused curricular components of STEM education are accompanied by particular instructional strategies including scientific inquiry, problem-solving, exploratory methods, and design-based learning (Kennedy & Odell, 2014;

Roberts, 2013). In addition to the requisite instructional strategies, an education in STEM is frequently defined as requiring a link between taught concepts and the real-world (Gomez & Albrecht, 2014; Reeve, 2014). Thus, STEM education is a holistic approach to science, technology, engineering, and mathematics, which incorporates specific instructional strategies that enable the learner to make connections between STEM subjects and *her or his life*, making it a culturally responsive form of education.

The impetus for STEM education springs forth from the number of benefits associated with this approach. Through STEM education's interconnected nature, learners are able to gain a non-compartmentalized view of STEM subjects, which enables them to better understand STEM subjects and the occurrences in their everyday lives (Reeve, 2014). In doing so, a quality STEM education provides the means for students to appreciate STEM, to learn about career options in STEM, and to potentially pursue STEM careers, filling the current gaps in the STEM workforce (Kennedy & Odell, 2014; Roberts, 2013). In the global workforce a country's STEM advances are a measure of its success, therefore, a country's STEM education directly shapes that success (Roberts, 2013). STEM education has the potential to nurture innovative minds in young learners, which would not only fuel a nation's success on a global scale but would undoubtedly benefit that nation internally through scientifically literate citizenry (Reeve, 2014).

Given the significance of STEM education, Blades (2008) cautions against privileging a particular philosophy of science education as the means for educating all citizens. Danger lies in accepting scientific findings without critically examining the scientific processes that led to them. Yet science education induces learners into accepting its authority as a master narrative (Blades, 2008). STEM education may follow suit if students are prevented from thinking critically about STEM itself. Not acknowledging how science is used to marginalize, or how science was used to explicitly propagate racism, and how it has been indebted to support from the military are examples of how learners can be restricted from thinking critically about science and in turn, STEM (Blades, 2008). Part of the informed citizenry that STEM aims to achieve involves the ability to interrogate epistemologies, including STEM. Blades (2008) maintains that science is a key discourse for informed citizenry but it is not solitary.

Quality STEM education, which the ILA strives for, must present STEM in a manner in which students become informed citizens, by using STEM to develop students' skills to think critically about the world around them, recognizing STEM's significance in society and its role in economic mobility, while concurrently acknowledging that STEM is one tool among others that is used for informed citizenry. Quality STEM teaching and learning can be brought into fruition by teaching students the integrated content; presenting them with a problem to solve that is relevant to that content and their lives; and providing them with training for the technological tools that they would use to design something tangible, which could be used to solve the problem. An example that can be used for students who are learning the unit on ecosystems in school, would be to challenge them to design a device to aid in protecting the local habitat of a particular organism. In this example, the challenge is not specific to African-Nova Scotian students, however, its introductory lessons should be designed to emphasize the achievements of people of African descent and include various views on species and habitat preservation. Prior to presenting the students with this challenge they would have learned about ecosystems, various technology used to protect ecosystems (including technology developed by scientists of African descent), and various ideologies (culturally responsive in particular) about the importance of habitat protection. Next, students will use inquiry-based learning to pose questions to research, to create their design, and to improve their design (Reeve, 2014). Students would be required to provide evidence for how their design addresses the problem. Additionally, students would need to show the pros *and cons* of their design, requiring them to think critically about the problem, their creation, and their use of STEM.

Implementation of STEM is problematic for learners in economically disadvantaged schools, where funding is limited (Kendricks & Arment, 2011). Lack of resources, invalidating students' cultural identities (through culturally irrelevant content and culturally irrelevant teaching methods), and not having varied forms of assessment, are a few of the barriers non-White students face in the classroom (Esmonde & Caswell, 2010; Ladson-Billings, 1995). These barriers need to be addressed in the STEM classroom to ensure that systemic reproductions of racism, in which the education institution marginalizes racial minorities by denying them access, are not advanced (Ladson-Billings, 1995; Mujawamariya, Hujaleh, & Lima-Kerckhoff, 2014). Racist reproductions prevent racial minorities from aspiring to STEM fields because they are denied access, at the same time, their exile from STEM is reinforced by these students not seeing anyone who looks like them in STEM fields. This makes it easy for these students to doubt their ability and internalize the lack of minority representation in these fields to the extent that they underperform in STEM subjects and cannot meet the academic requirements to pursue STEM further (Sensoy & DiAngelo, 2012).

As mentioned prior, the ILA is attempting to redress the under-representation of minorities in STEM, specifically African Nova Scotians, by offering them after-school programming that has a STEM focus. The ILA's use of the term STEM, similar to its use in the revised 2014 Nova Scotia curriculum documents, does not delve into further details about STEM education but uses the acronym to abbreviate the STEM subjects. The ILA consistently uses the term within the context of increasing the representation of African Nova Scotians in the fields of science, technology, engineering, and mathematics. The ILA gives their learners the opportunity to engage in quality STEM education, by providing them with the resources to take part in a provincial robotics competition, providing them with the opportunity to learn the mandated Nova Scotian curriculum content by presenting it in an integrated way, and by enabling students to relate what they learn to their lives and more specifically to being a Black learner.

Purpose

The purpose of this sequential explanatory mixed methods study is to determine whether the participants of the Imhotep's Legacy Academy After School Project (ILASP) have been influenced by the programmes to view STEM fields positively. The After School Project involves mentors meeting with students of African descent on a weekly basis and instructing them with a pre-developed, hands-on, STEM curriculum related to the Nova Scotia curriculum expectations (Imhotep's Legacy Academy, 2014). As the appointed researcher, by the ILA, of the after-school programme, I took the position of a critical friend. The ILA was aware of my stance as a critical friend. According to the authors of "The diverse role of the critical friend in supporting educational action research projects" (Kember et al., 1997), a critical friend is a researcher who, instead of viewing him or herself as a consultant, views him or herself as a supportive partner.

The findings will also add to the body of research involving students of African descent in STEM because my 2014 review of the literature did not find any research involving junior high students' perceptions relating to the value of access programmes. As well, the type of research question and the methodology employed is uncommon to this area of study, where usually the answers to the research question are sought through an ethnography, where one would immerse herself or himself in the culture being studied, or a quantitative methodology involving survey research. Instead, the use of a mixed methods sequential explanatory design, which incorporates a survey followed by four interviews (one interview with a student who has a positive attitude towards STEM, another with a student with a negative attitude towards STEM, another interview with a student with an attitude representative of the surveyed group, and lastly, an interview with a student who has an indifferent attitude towards STEM), will be employed and in doing so, this methodology is expected to provide the breadth of perspectives that will aid in understanding participants' views on how the ILA has influenced them to view STEM.

Research Question

The objectives of the ILA are to provide African Nova Scotian youth with a greater awareness of STEM, to bolster enrolment of African Nova Scotians in post-secondary STEM programmes, and to increase representation of African Nova Scotians in STEM professions (Imhotep's Legacy Academy, 2014). To evaluate whether the ILASP is meeting its objective to increase STEM awareness and to evaluate whether it is on track to meet the objectives regarding students' academic and career aspirations, the study posited the following research question.

- What are present ILA participants' perspectives on the ILASP's impact on their views of STEM fields, their academic choices, and their career choices?

This research aimed to identify whether the ILA has influenced its current participants to have a positive view of STEM: if so, how has the ILA achieved this? If not, how can it strive to do so? This study looked at the ILA's current participants because the ILA still has a chance to reach these students. I believed that these students, rather than those who have already went through the programme, will be better able to voice how the ILA can help them specifically and outline what works best for their learning. Some of the sub-questions that this study investigated looked at the ILA’s strategies for framing STEM content. Four of the main sub-questions are listed below.

- How has the ILA’s programming (content, non-formal ambiance, and pedagogical practices) influenced students to view STEM?
- How have Black representative STEM mentors influenced students to view STEM?
- How has learning about the achievements of Black scientists helped students to view STEM?
- Lastly, how have the combination of representative Black mentors and learning about the accolades of Black scientist helped students to envision themselves in STEM?

The answers to these questions provided the ILA with insights into the particular aspects of their programming that build positive STEM attitudes in their students, as well as, aspects of their programming that fell short of this goal.

Transformative Approach

This research is based on a transformative mixed methods approach, which aspires to create change (Creswell, 2014). In particular, this study sought to create change within the ILA, by evaluating its effectiveness and by using the findings to inform what can be changed to help improve the ILA. The transformative worldview acknowledges issues of power, social justice, discrimination, and oppression. Transformative studies are often collaborative in nature, meaning the organization, group, or participants being “researched” will be involved in the research process. In my study of the ILA after-school programme, I collaborated with the ILA to design research methods that we both believed would work well for a programme evaluation. Transformative research aims to listen to the voice of its participants and share their voice. This study was entirely based on students’ perceptions. All of the students’ recommendations were shared with the ILA with students' quotes. The overall goal transformative research involves an action agenda, which seeks to create change in the lives of the participants, researchers, and institutions (Creswell, 2014; Mertens, 2010). Unlike participatory action research where the students would decide what changes need to be made, this study left that decision to the ILA. That said, this research ensured that students' views were the basis for that decision because all of the data, findings, and recommendations were based on students' perspectives. Overall, this research provided insight into how students are influenced by this particular informal STEM education programme. These insights are necessary for the programme to make improvements, to learn what has been working well and to strategize for the future. The outcomes of this research will be used to influence changes in the ILASP curricula.

The issues of power, social justice, and oppression have been touched on in the statement of the problem and will be further explored in the literature review, but as an integral component of the transformative approach these issues will be explained within that context. Power is defined by Sensoy and DiAngelo (2012) as "the ideological, technical, and discursive elements by which those in authority impose their ideas and interests on everyone" (p. 52). One cannot oppress unless the group they belong to holds institutional power, making them able to control the dominant worldview, rules, and discourses that society view as normal; this form of domination does not happen overnight but is historical and present within the education system (Hatcher, Bartlette, Marshall A., & Marshall M., 2009; Sensoy & DiAngelo, 2012). Curriculum reinforces power inequalities where (White Europeans) are privileged and (non-White/non-European) are disadvantaged (Higgins, 2014; Mujawamariya, Hujaleh, & Lima-Kerckhoff, 2014). The STEM curriculum is not exempt as there is no acknowledgement of the contributions of those of African descent to STEM (Minister's Panel on Education, 2014). One of the main ways power is demonstrated in the education institution is when structures within schools, such as staff and their belief systems, do not consider the various ways people perceive the world, preventing students with non-dominant worldviews from being active in the schooling process (Emdin, 2010b; Higgins, 2014; Mujawamariya, Hujaleh, & Lima-Kerckhoff, 2014). In Nova Scotia there are Black student support workers who are hired to help Black students navigate their academic lives, however, having these workers creates a false sense in the non-Black teachers that they do not need to engage in other belief systems (Enidlee Consultants Inc., & Nova Scotia Department of Education, 2009).

In *Urban Science Education for the Hip-Hop Generation,* Emdin (2010b) argues structures within schools, such as staff who do not consider the various ways people perceive the world, "support reductionist approaches to instruction and viewing the world, that require African-American [non-Euro-White] individuals who are involved in highly communal [cultural] practices based on oral traditions, community, coteaching, and colearning to remove themselves from their [culturally responsive] norms of their communities and adopt an alien [Euro-Western *Whitestream*] approach to teaching and learning" (p. 30). Thus, a curriculum that only reflects Euro-Westerncentric worldviews and privilege teachers who prefer the status quo of the dominant neo-liberal worldview or *Whitestream* approach to engaging youth in any of the STEM fields, are oppressive.

Researchers (Emdin, 2010b; Tate, 2001) have shown that conventional Whitestream/mainstream teaching methods are not effective for engaging racialized and marginalized youth in STEM classes, yet, regardless of the reasons for academic disparities and in spite of the research on how students learn STEM, changes in praxis have been slow. As a result, informal STEM programmes, including the ILASP, strive to provide an alternate atmosphere for learning STEM, a culturally responsive space where the non-dominant worldviews, are accepted, appreciated, and discussed. In this programme, the systemic structures that oppress (irrelevant curricula, irrelevant teaching methods, lack of resources, teachers with *Whitestream* worldviews) are replaced with structures that are designed to liberate (culturally responsive pedagogy, tangible resources for STEM pedagogy and mentors/instructors who are racially representative of the students and who support worldviews that are not Euro-Westerncentric). As such, one may categorize the ILA as an organization that operates based on a transformative worldview, with the aim of improving the achievement of Black students in STEM. Similarly, this research is transformative in that it strives to help the ILA evaluate the effectiveness of their programming.

Significance of Research

This study is consequential for the ILA, the students involved, and their respective learning communities. As a programme evaluation, the research from this study informed the ILA of whether or not it is meeting its goals. The quantitative section of this research targeted the question: has the ILA influenced its participants to view STEM in a positive light, while the qualitative section dug deeper into this question to provide a better understanding of how the ILA has done so and how it can strive to do so. This study also served the ILA by providing this organization with research that could potentially be used to aid in validating the programme, and in acquiring funding. This research is the first time the ILA has been studied externally and as a result will be very significant for the ILA in upcoming discussions of its funding and its impact on African Nova Scotian learners.

Personal ground.

It is essential that I clarify my background as part of making this research more valid. I am a Guyanese-Canadian, both of my parents were born in Guyana and I was born in Canada. My dad is an Indo-Guyanese and my mom is of mixed race, Indo-Guyanese and White. I grew up in one of Toronto's urban and ethnically diverse neighborhoods, Malvern. The teachers I had, throughout my elementary and high school years, were also ethnically diverse. My high school was known more for its basketball team and student pregnancies than its academics. I was a student athlete who played almost every sport offered and took classes that had a reputation of being "tough," (science and math). The students who were on my sports teams were often not in the academic stream with me. I hated the way my high school chemistry teacher taught science and I thought about dropping the course. However, I had another teacher who influenced me to continue taking science courses, to go to university, and to do a degree in science.

While doing my final year of my chemistry degree at Saint Francis Xavier University I was employed by the ILA. Four years ago, I was a part of the ILASP team, as a mentor for the grade 8 students (these students are no longer participants in the programme because they are now in older grades). As a mentor I met with students, presented them with a pre-developed science curriculum, and tried to support and encourage them to persevere in school. I grew quite fond of the programme and I believed it was valuable. I remember on one occasion, towards the beginning of the programme another mentor asked the students what they aspired to be when they grew up. The students replied with all the infamous careers of Blacks portrayed in the media; a rapper, a dancer, a basketball player, etc. Only one child said she wanted to work in a STEM field as a veterinarian. As my short time with the ILASP progressed I witnessed students become engaged in several STEM activities. I never knew if their engagement marked a real shift in their perceptions of STEM or not. I believe by conducting this research I will be able to reveal more about the ILASP's impact on participants' perceptions, which in turn will help the ILASP to become a stronger programme. It is of no benefit for me to share one-sided results and bearing in mind the objectives of the programme, it is no benefit to the ILA if data is not presented with absolute care for validity. That said, I used a research diary as an extra precaution to guard against my own biases by recording detailed notes that include reflections on my own subjectivity (Bogdan & Biklen, 2007).

Literature Review

The literature review for this research was situated in several broad areas, which included critical race theory, culturally responsive pedagogy, the history of Black education in Nova Scotia, and existing after-school programmes, to better understand the issues and successes the ILA may encounter, based on the unique demographic it serves.

Critical Race Theory

Critical Race Theory (CRT) was developed by Bell, Crenshaw, and Freeman in the mid-1970s, to focus on race based inequities found throughout US jurisprudence (Marx, 2008). The application of CRT to education occurred in 1995 when Gloria Ladson-Billings and William Tate used CRT to explain racial inequities in students' achievement, in schooling, and throughout society (Marx, 2008). CRT is a multidimensional theoretical perspective comprised of several key tenets, which include the normal and embedded nature of racism in society, schools included; the permanence of racism; the existence of interest convergence, which occurs when the dominant group allows legal change to be made towards equity when those changes best serve the needs of the dominant group; and lastly, through identifying racism and legitimizing accounts from those who have experienced racism, the goal of dismantling the systemic nature of racism can be reached (Marx, 2008).

One of the most frequent techniques used in CRT is storytelling, particularly the identification of stock stories and the use of counter-stories. Stock stories provide explanations for an occurrence in society that is in accord with the dominant culture, whereas, counter stories allow those with stories that are contrary to stock stories, to voice their experiences. This research on the ILA is positioned within Critical Race Theory as it holds to the tenets of CRT and uses the counter story telling technique. Additionally, this research provides the marginalized with a space to voice their views if they choose and allows varying perspectives to be provided, which are other token aspects of CRT (Marx, 2008).

Similarly, Dei's (2008) research in Black students' education is heavily based in CRT. Dei (2008) states that racism is embedded in our social fabric, including the school system, where it is institutionalized to the extent that Whiteness is normative. Though often denied, the presence of racism in the education system serves to substantiate its presence in society and maintains the status quo. Subtle racism, can be seen in the education system in the way its definition of success is limited to the dominant culture's view and in the way the needs of minority students are not being met.

Dei (2008) believes the Canadian education system individualizes success and marginalizes those whose cultures promote community. He argues for educators to redefine success and to move towards a more inclusive view of education, which he refers to as schooling as community. Due to the exclusive nature of an individualistic model for success, Dei argues that it is imperative that educators redefine success to include the academic, social, spiritual, and cultural development of the learner, which will enable the strengths of various learners to be praised and used to enrich schooling for all learners (Dei, 2008). Dei's vision for schooling as community is demonstrated in programmes like the ILA, which foster a school-community partnership, where students in the programme meet members of the community who are succeeding in STEM fields and where ILA staff partner with the local community to support participants, to promote student engagement, to contest the dominant individualized notion of success, and to share other ideologies through cultural proverbs and analogies when teaching.

Individualized meritocracy, another dominant view of success disputed by Critical Race Theorists (Dei, 2002; Satzewich & Liodakis, 2013; Tate, 2001), claim that all students have an equal opportunity to excel in school and society. In this ideology one's achievements are accredited solely to her or his merits (Sensoy & DiAngelo, 2012). However, all students do not have their cultures represented equally in schools, placing them at a disadvantage when compared to students belonging to the dominant culture or privileged group. Therefore, when students from the non-privileged group do not excel they are viewed as incapable or it is assumed that they do not try hard enough, when in fact the underachievement could be due to a number of factors, including not having their cultures represented in schools (Dei, 2002; Satzewich & Liodakis, 2013; Tate, 2001).

CRT's cultural difference paradigm reveals that through ignoring or alienating students from their home cultures, schools prevent ethnic minorities from achieving (Collins & Solomos, 2010; Emdin, 2010b). In fact, traditional science education has been described as attempting to enculturate students to Western science, forcing them to assimilate to neo-colonial imperialism (Aikenhead, 2001). The Nova Scotia Ministry of Education's 2014 report advised that the curriculum should become inclusive of African Nova Scotian content to promote the success of all students (Minister's Panel on Education, 2014). This statement indicates that curricula are lacking in African Nova Scotian voices and perspectives, making them less relevant to the African Nova Scotian learner. Students who recognize that the curricula do not reflect their views are especially at risk because research shows that when students are faced with a culturally irrelevant curriculum and they choose not to assimilate, their response is to alienate themselves from learning (Emdin, 2011a). Emdin (2011a) believes alienating oneself in the classroom is a reaction to the oppression that minority students face in the education system. The ILA makes a point of using culturally responsive teaching, integrating students' cultures into their lessons to prevent the detrimental effects on students learning that result from being taught a culturally irrelevant curriculum (Imhotep's Legacy Academy, 2014).

Along with experiencing feelings of being forced to assimilate or alienate oneself in the classroom, minority students may also experience internalized racial oppression and stereotype threat. According to Sensoy and DiAngelo (2012), "Internalized racial oppression occurs when a person of Colo[u]r, consciously and subconsciously, accepts the negative representation or invisibility of people of Colo[u]r in media, education, medicine, science, and all other aspects of society" (p. 113). When a student of Colour internalizes these negative depictions they are less likely to believe they can excel in the aforementioned fields and even less likely to try. Having similar negative effects is stereotype threat, which is the "…anxiety individuals from stigmatized groups have that their behaviour might confirm - to others or even themselves - the negative stereotypes imposed upon their group" (Beasley & Fischer, 2012, p. 429). By that token, stereotypes about people of Colour being incapable of achieving in STEM fields can cause a student of Colour to experience anxiety and perform subpar. To counteract the effects of stereotype threat and internalized racial oppression, the ILA teaches their participants about the successes of the Black community, including their mentors who are currently taking STEM courses in university, in order to expose their participants to successful Blacks (Imhotep's Legacy Academy).

Culturally Responsive Pedagogy

Culturally Responsive Pedagogy is a strategy used to ameliorate the effects of feeling alienated in class, facing stereotype threat, and dealing with internalized racial oppression. Culturally responsive pedagogy is educating based on the knowledge of the life experiences and the *culture of students,* to facilitate learning in a method that is applicable to *their needs* (Wallace

& Brand, 2012). This conceptual approach combats the mediocre classroom experience that is generated from the monocultural content of the school curriculum (Codjoe, 2006). Emdin (2010a), reiterating that schools promote a monoculture, identifies it as dominating education through curricula and forms of teaching that are Western or Eurocentric. Pertaining to teachers, culturally responsive pedagogy requires educators to have an understanding of how different groups demonstrate power dynamics in schools (Greenwood, 2014).

Unlike traditional teaching methods, culturally responsive pedagogy does not deny Black cultural knowledge by underrepresentation, nor does it invalidate Black cultural knowledge. The ILA uses African proverbs and teaching through culturally relevant analogies as ways of engaging and validating students' cultural knowledge (Nashon, 2003). Codjoe (2006) states, to invalidate Black cultural knowledge would be to adversely affect the identity of Black students by perpetuating the misconception that Black children are incapable of excelling. Instead, culturally responsive pedagogy is the remedy to such misconceptions. Dei (2001) believes that at its core, culturally responsive pedagogy must work with the ways of students' ancestral cultural knowledge retentions and explore the roles of culture and identity. Codjoe's (2006) research on culture and identity confirms that a strong sense of Black cultural identity: enabled students to have coping skills when faced with racism; counteracted the effects of devaluation of Blacks; and affirmed that students did not need to act White to succeed. Dei (2001) echoes that culturally responsive pedagogy must embrace "the importance of the creative self and personhood as a path to individual and collective knowledge" (p. 348) and must cultivate communal learning. The ILA strives to foster communal learning and to birth a positive Black cultural identity in its students, through exposing them to the successes of their community, promoting African proverbs, teaching the students about the work of Black scientists, and by allowing students to speak from their own cultural perspective without the stigma of sounding “unscientific”.

Emdin (2011a), a leading researcher in urban science education, has shown that when teachers value the voice of their students in the classroom, students are given an opportunity to acquire social capital, which creates a space where all students are willing to participate. Aikenhead (2001) believes that providing open dialogue, specific to Western science’s role in colonization, will aid students in autonomous acculturation; learning Western science without necessarily accepting its values.

Introducing students to and validating the values of their cultural group can be done with mentoring, which studies have shown to be influential in minority students’ STEM academic achievement and in increasing their desire to pursue STEM careers (Kendricks, Nedunuri, & Arment, 2013, Weber, 2011). Mentoring not only fosters a nurturing environment where students feel safe and welcome to participate, but it also combats the effects of internalized racial oppression and stereotype threat. By having minority mentors that are representative of the student population, students identify positively with that field and believe that they can aspire to succeed in that field as well. Having multiple mentors that are representative of the stereotyped group and are vocal about being a member of that group, while succeeding in the stereotyped field, has been shown to inculcate students to disbelieve those stereotypes (Emdin, 2010b). As a result, mentoring, combined with culturally relevant content and culturally relevant teaching methods, is effective in refuting stereotype threat, opposing internalized racial oppression, and fostering a safe and amicable atmosphere, necessary for minority students to succeed in STEM.

Social Climate

In Nova Scotia, the need for a safe and amicable learning climate, created through culturally responsive pedagogy, is expressed in the 1994 BLAC Report on Education: *Redressing Inequity-Empowering Black Learners, the Reality Check Report* (Enidlee Consultants Inc., & Nova Scotia Department of Education, 2009), and the 2014 Report of the Minister's Panel on Education for Nova Scotia. The BLAC Report (1994), based on a four-year study of inequity and institutional racism in the Nova Scotian education system, found that

> Clear deficiencies that exist include the shortage of policies affecting race relations at the Board and school levels; the need for school curriculum and policies to accommodate cultural diversity; the need to realign the relationship between the home and the school; the lack of any development of creative and resourceful programs for teachers' professional training, maturation and growth in a multicultural and multiracial society; a scarcity of Black role models in the systems, methods to respond to racial harassment, and the assessment of students for placement; the lack of an effective process to evaluate textbooks for bias and the absence of materials to engender more positive attitudes in the African Nova Scotian student. (p. 13)

Years later the Reality Check Report (2009), a review of the effectiveness of programmes initiated based on the BLAC report to enhance the achievement and opportunities of Black students, shockingly states that, "When the BLAC Report was presented… it was acknowledged by the government that institutional racism was… limiting opportunity and achievement for African Nova Scotian learners. Today, the concept of institutional racism appears to have slipped out of focus" (p. 10). The report went on to mention that Black learners were viewed as the exclusive responsibility of Black educators (Enidlee Consultants Inc., & Nova Scotia Department of Education, 2009).

The Fall 2014 report on Education, *Disrupting the Status Quo: Nova Scotians Demand a Better Future for Every Student*, found that African Nova Scotian students and their families are less likely to feel welcome in schools and were 30% less likely than respondents of Acadian or European descent to agree that schools are committed to equity and human rights (Minister's Panel on Education). The report also advised that curricula should be inclusive of African Nova Scotian content to promote the success of all students (Minister's Panel on Education, 2014). In general, the *Disrupting the Status Quo Report* found that Nova Scotian students' performance falls significantly below that of students elsewhere in the country and that there were critical gaps in the curriculum in the area of STEM (Minister's Panel on Education, 2014). The need for improvement in the Nova Scotian school atmospheres, coupled with the need for improvement in STEM subjects, places African Nova Scotian students and other minorities at a greater disadvantage when it comes to succeeding in STEM.

As a result, informal education programmes such as the ILA have taken it upon themselves to offer STEM education to students, which redresses several of the issues facing African Nova Scotian youth. Particularly, the deficiencies mentioned in the BLAC Report regarding the need for curricula to accommodate cultural diversity and the deficiencies regarding the lack of development of creative and resourceful programmes for teachers' professional training, have been addressed by the ILA through the use of cultural curricular content in all ILA activities and through PD sessions, which inform mentors/instructors and other ILA staff about the historic and systemic plight facing African Nova Scotian students. The ILA has also endeavoured to realign the relationship between the home and the school by having parent meet and greet nights, by maintaining communication with parents, and by having events where parents can witness their child engaging in STEM activities. To compensate for the scarcity of Black role models in the education system and the absence of curricular content to engender more positive attitudes in the African Nova Scotian student, the ILA hires mentors who are of African descent and are achieving in STEM at the post-secondary level to present pre-developed STEM curriculum that is designed to cultivate a positive Black identity in students and a positive attitude towards STEM.

Other After-school Science Programmes

Other informal STEM education programmes in different jurisdictions, including The Scholars Program (Kendricks & Arment, 2011), Girls' Night Out (Weber, 2011), and the Boys and Girls Club (Eglash, Gilbert, Taylor, & Geier, 2013) have taken the initiative to present STEM topics in a relevant way for minority students, in an effort to provide culturally responsive pedagogy when it is deficient in the formal classroom.

The Scholars Program has similar goals to the ILA and is offered to college students by Central State University, located in Ohio. Central State University is a historically Black university, and has successfully used culturally relevant STEM practices from the K-12 classroom in the college environment (Kendricks & Arment, 2011). One of these practices, again similar to the ILA, is to have caring teachers that were more than willing to work with the programme's participants. It may seem obvious that a teacher/mentor should be caring, however, teachers that are not informed about the issues facing Black youth (not feeling welcomed in schools because of their race, not feeling represented in texts because of systemic racism, stereotype threat, internalized racial oppression… etc.), may have misperceptions that result in Black students not feeling cared for. Emdin (2010a) states, "…the 'normal' student is perceived (in both media and academic circles) as interested in succeeding in school, achieving in science, and demonstrating appropriate behaviour, urban students [or students of colour] are regarded as uninterested in school, difficult to teach, and unable to do well in challenging academic subjects" (p. 2). With this kind of deficit perception, it is easy for White (non-Black) teachers to disregard students who they feel are disengaged, which is precisely why teachers need to recognize the issues facing Black youth and create a safe space for them to learn, and why the ILA hires African Nova Scotian mentors or mentors of African descent. Similarly, the Central State University programme made a point of creating a community environment by having caring teachers. Research of this programme found that there was "increased student performance and retention rates for minorities in STEM… [and] a more nurturing environment was created in which students felt safe, comfortable, and supported…" (Kendricks & Arment, 2011, p. 27).

Other programmes with the objective of increasing minority students' achievement in STEM have also enlisted the use of role models that are representative of the demographic being reached. One of these STEM programmes developed by California University of Pennsylvania, offered a Girls' Night Out at the California Middle School, where the girls participated in fun STEM activities (Weber, 2011). Surveys were administered to the female students prior to participating in the Girls' Night Out programme and then another survey was administered a week after their participation. The survey results indicated that the girls had an increased interest in STEM-related fields. Similar results were found in Kendricks, Nedunuri, and Arment's (2013) research of students' satisfaction with mentoring offered from the Central State University's Scholars Program. In their study, survey results indicated that "Students perceived that mentoring was the biggest contributing factor to their academic success" (Kendricks, Nedunuri,

& Arment, 2013, p. 42). The results coincided with other studies, which found that exposure to role models have been linked to improved attitudes toward science (Weber, 2011).

Literature Gaps

Studies on students' attitudes towards science have covered a wide range of participant demographics varying by gender, race, and age, however, a review of the literature involving Black students in STEM does not find any research pertaining to African Nova Scotian junior high students' perceptions of the value of access programmes. Junior high students are at a critical age, an age when negative STEM experiences will cause student disengagement and undoubtedly prevent pupils from attaining the necessary foundation to excel in STEM courses later on in life, whereas, a positive STEM experience can influence them to go on to pursue a STEM enriched academic career.

Past studies have indicated factors that have inhibited minority students' from gaining a solid foundation in STEM and have prevented further success in STEM. In spite of this, Dei (2008) notes that scholarship regarding solutions to underachievement in the Black academic experience are lacking. Studies have neither explored how solutions have been implemented in the classroom nor evaluated how those solutions have impacted students' engagement with STEM. For instance, Codjoe (2006) and Dei (2008) have done tremendous work in determining and propounding that affirmation in Black racial and cultural identity is one of the most pertinent factors in Black Canadians' academic achievement. Yet there have been few that evaluate the impacts of how formal education and informal education have utilized identity affirmation to help Black Canadians realize their potential. Similarly, numerous studies have determined reasons for why there is a disproportionate number of Black students showing underachievement (Codjoe, 2006; Emdin, 2011a; Smith, Schneider, & Ruck, 2005; Tate, 2001), yet, there is minimal research exploring how effectively reasons for underachievement have been dealt with in the formal and informal classroom. The findings from this study expand the literature on informal science programmes, by focusing on the ILA’s effectiveness in positively changing African Nova Scotian students’ perspectives on STEM.

Methods

Research Design

This study applied a mixed methods approach, which entailed using both quantitative (survey) and qualitative (interview) techniques for collecting and analyzing data and then integrating both forms of data to provide more information for the programme evaluation (Creswell, 2014). A general rationale for mixed methods is that through the use of both qualitative and quantitative research, this approach minimizes the limitations found when using either type of research on its own (Creswell, 2014). Additionally, the mixed methods approach allows the researcher to compare different perspectives from quantitative and qualitative data and it allows the researcher to use both open-ended and closed-ended questions.

Particular to this study, the mixed methods approach provided an explanation of quantitative results with qualitative data and it allowed the researcher to develop a more thorough understanding of changes that can be done to aid the marginalized group (Creswell, 2014). The quantitative and qualitative data collection and data analysis stages in this particular study were connected through an explanatory design in which the quantitative data was collected first and analyzed prior to the collection and analysis of the qualitative data. This mixed methods framework enabled the different elements of the research process to be unified, allowing the researcher to create a coherent understanding of the ILA has met its objectives and how it can improve (Plowright, 2011). An online survey, distributed to all of the current participants in the ILA, addressed whether or not the programme influenced its participants to value STEM fields highly, to pursue STEM courses in their academic career, and to aspire to careers in STEM fields. Succeeding this was the qualitative phase of this study, interviews with four students discussed the content of their survey results in greater depth.

Participants

The target population for the survey section of this study was all of the current participants who attended the ILASP during this school year. However, recruiting of the participants was done across 4 of the 5 sites, which are located in Halifax, Dartmouth, Truro, Antigonish, and Cape Breton. (Students from the Antigonish site did not partake in the study.) The students who were involved in the study were in grades 7 to 9. Of the 11 students who completed the surveys, four were selected to have face-to-face interviews with the researcher. The four who were selected had varying survey responses. Both males and females were interviewed and those selected for interviews represented all grades, and were from different sites. Hence, students with varying survey responses (positive STEM attitude, negative STEM attitude, attitude representative of the group and indifferent STEM attitude) were chosen to gain a broader understanding of participants' perspectives. The interview participants are described in Chapter 4.

Data Collection Instruments & Data Collection Procedure

A survey designed by myself was used to collect data for the quantitative phase of this study. As aforementioned, data from the quantitative phase of the study was used to inform the participant selection in the qualitative phase of this study, in which semi-structured interviews were conducted.

Survey.

The survey consisted of six demographic questions, one open ended question, one "check all that apply" question, one "yes" or "no" question, and thirty-one Likert items, 22 of which made up the scale for how the ILA impacted the students' perceptions and the other 9 measured what students believed their perceptions were prior to attending the ILA. For instance a question from the "ILA perceptions" scale asks students how much they agree with the statement that, "Attending the ILA made me want to go to college to take STEM courses," while a Likert question that was part of "pre ILA perceptions" scale asks students how much they agree that, "Prior to attending the ILA, I wanted to go to college." All of the Likert items required participants to identify how much they agreed with a statement by selecting any of the options including strongly disagree, disagree, neither disagree nor agree, agree, and strongly agree. The demographic questions provided information regarding the participant's age, gender, how many years he or she has been involved with the ILA, and what his or her attendance was for the ILASP programmes attended.

The author administered the surveys, which were accessed by students online through Survey Monkey. Only ILASP participants that returned positive parental consent were asked to complete the survey in their classroom. No personnel from the ILASP were present in the room where the online survey was administered. In addition, each participant had the right to determine for himself or herself whether to participate in the survey and this was achieved through a consent form that was given online as a prerequisite to accessing the survey.

Unfortunately, all of the students at the Antigonish location did not consent to the study. Without the Antigonish students' participation in the survey, the number of participants in the survey was significantly decreased. In addition, two other participants were not given parental consent to be in the survey. This resulted in 11/13 students responding to the survey, who were from the sites in Dartmouth, Cape Breton, Halifax, and Truro.

Interview.

A case study methodology was implemented for the qualitative research phase. The case study approach favours gathering information about a delimited phenomenon, such as, students participating in an after-school STEM programme (Gerring, 2007). Baxter and Jack (2008) state that case studies seek to answer the question, why? Particular to this research study, the questions for the case study sought to understand *why* students responded the way they did in the survey. Multiple cases were used, with each case based on one of four participants who were selected as key informants and interviewed individually. The multiple case study method is applied when the context for each case differs (Baxter & Jack, 2008). In this study, the students' external STEM influences varied based on their parents' support and their experiences in school, resulting in each student having a different experiential context. Data for each case were collected through students' illustrations of a scientist and through interviews. The interviews were separate and semi-structured to acquire in-depth data about the interviewees' experiences with the ILASP and its influence on their lives. The interviews enabled the researcher to learn about student narratives. Codjoe (2006) highlights the strength of narratives by stating, "although subjective, [narratives] lend empirical support to the existing knowledge on race and education and inform the (re)theorisation of race, difference and schooling in North America" (p. 366).

The selected interview participants were heterogeneous, having differing survey results, to gain insight into a variety of students' perspectives (Gerring, 2007). Triangulation was achieved through the analysis of other data sources including researcher observations during the interviews, students' surveys, and students' drawings. These data sources were used to gain a fuller understanding of the participants' experiences. The interview itself, included questions about students' experiences with the ILA and STEM, with the purpose of learning, through student narratives, how the ILA impacted students' academic and career aspirations.

The interview included a draw-a-scientist question similar to the research done by Chambers (1983), who asked students to draw a scientist to determine at "what age children first develop distinctive images of the scientist" (p. 257). In Chambers' study images were examined for several stereotypical elements including a lab coat, eyeglasses, facial hair, lab equipment, symbols of knowledge (books, filling cabinets), technology, and relevant scientific captions. Chambers found that the number of elements increased as students progressed through school, indicating their depiction of a scientist became more stereotypical. According to Chambers, the students asked to draw a scientist in the interview would be expected to draw a scientist with at least 3 of the stereotypical elements. That said, Chambers (1983) research did not count race as a stereotypical element of a scientist, thus a hypothesis cannot be drawn from his study regarding what race the interviewees would make their scientist. Nonetheless, the 'draw a scientist' question was included in the interview as an indirect way of inquiring about students' combined perceptions of race and scientists because when asked to colour in their scientist students had to choose a skin colour, and in doing so they, consciously or subconsciously, had to make a decision about the race of their scientist. The ILA seeks to inform their participants about the accomplishments of Black scientists and this question (as well as follow-up questions about the drawing) will also serve in determining whether students draw Black scientists because of what they have learned from the ILA.

Data Analysis

Each piece of data was initially analyzed separately with the survey analyzed first, followed by the interviews, the scientist drawings, and then the researcher's observations. Afterwards the data were analyzed together.

Survey.

Once all the surveys were completed students' responses were exported from Survey Monkey into SPSS and the Likert items were coded numerically with the following conversion:

Strongly Agree = 5, Agree = 4, Neither Disagree nor Agree = 3, Disagree = 2, and Strongly Disagree = 1. Likert items were also worded negatively to mitigate response bias and these items were coded in reverse, such that Strongly Disagree = 5 and Strongly Agree = 1. Once, coded in SPSS the questions were analyzed for frequency distribution, which quickly indicated the number of nonresponses and outliers.

A cross tabulation analysis was done to determine whether or not those who had participated in the programme for a longer period of time were more inclined to respond that the ILASP influenced them to pursue STEM classes in their academics. A similar cross tabulation was done to determine whether or not those who participated in the programme for a longer period of time were more inclined to respond that the ILASP has influenced them to aspire to STEM careers.

The responses to Likert items were analyzed with a Cronbach's Alpha test to calculate the internal consistency of the scores using SPSS (*Handbook of Survey Research*, 2010). Usually the responses to each Likert item in the scale would be assigned a numeric value and for each respondent the average of those numeric values would represent either a positive perception, if it were a high value, or a negative perception if it were a low value. Due to the small sample size 11/13, calculating averages for the scale would not be viable as the margin of sampling error, which results from sampling a subset of the population and not the entire population, increases when the sample size decreases (Bautista, 2012). As a result of not being able to use averages because of the wide confidence interval, the median and the interquartile range were found for all items (Moutinho, 2011).

Interview.

Each student who was interviewed was treated as a separate case. Their interview and drawings were the primary sources of data for each case. All interviews were transcribed, the transcriptions as well as pictures, were coded and analyzed for themes with the use of Atlas TI, a software for qualitative data analysis. Initially, I read through the transcripts and made notes of anything that stood out to me. Next, I read through the transcripts and chunked the text by segmenting and labelling it to produce a series of codes. To ensure validity in the developed codes I used member checking with the interviewed participants (Merriam, 1998). After codes were developed and checked, I used the classical content analysis technique which involves counting the number of times codes appear, to determine what information is of greater importance (Leech & Onwuegbuzie, 2007). Cases were analyzed individually, then all the case studies were compared with each other for common themes.

Mixed methods.

The data analysis techniques discussed in the survey and interview data analysis sections were all part of the mixed methods data analysis procedures. Due to the fact that this research project is based on a sequential explanatory design and a transformative design both of these approaches influenced the mixed methods data analysis procedures. Particularly, with regards to the explanatory design, the mixed methods data analysis pertains to how the qualitative results help to inform the quantitative results (Creswell & Clark, 2011). This type of analysis is referred to as a connected mixed methods data analysis (Creswell & Clark, 2011). Interpreting connected results is sometimes referred to as drawing conclusions or drawing inferences (Creswell & Clark, 2011). Inferences were made for the quantitative phase and the qualitative phase separately. At the end of the study meta-inferences were drawn. These inferences were included in the larger interpretation of the study. Specific to an explanatory design, meta-inferences address whether the qualitative data yielded a better understanding of the research problem than the quantitative data would on its own. Keeping in mind that this research project is based on transformative philosophical foundations, there were also inferences that needed to be made which catered to the transformative approach. These inferences were taken from the combination of both quantitative and qualitative phases and interpreted in relation to how the results reveal injustice and how the results suggest change.

Validation

Analyzing data required the utmost care for validity, which is the soundness or trustworthiness of the inferences that result from the collected data (Sanders, 1994). Guba and Lincoln (1989) describe internal validity to be the extent to which a given inquiry establishes how things really are or really work, whereas, external validity is defined as how applicable the findings are to other contexts. Validation is the process of gathering evidence that supports the interpretations of data, the uses of data, and collection processes of data: making validation a necessary occurrence throughout the research process (Sanders, 1994). Several strategies were used in this research project to ensure validity.

To start with, detailed descriptions of the constructs of this research project were provided to prove that the framework in use has a firm foundation, detailing how procedures were expected to be implemented, how the survey was administered and scored, as well as, how the interview was conducted and coded. A rationale for the chosen methodology has been provided. This framework was supported by the President of the ILA who concurred that the process would suffice the needs of the research question. As part of this framework, the Board of the ILA recognized that participants would be surveyed for their perspectives and that the researcher would present her analysis of this data with a focus upon programme strengths and development. The provision of a detailed description of the framework used, as well as, the rationale for its use makes this project more trustworthy (Sanders, 1994).

A variety of more particular strategies were used to aid in the trustworthiness of this research. In both the qualitative and quantitative phases of this research, it was imperative that all questions, in the survey and interview were easily understood. Due to the fact that participants are in junior high, simple language was used to ensure that they did not misunderstand what was asked of them, which would skew the results. Questions were written without multiple parts and they were individually checked with an automated reading level checker to safeguard against possible misunderstandings.

The use of member checking helped to determine whether participants understood what was asked of them and whether my interpretations of what participants said was accurate. Member checking occurs when the researcher returns the semi-polished findings, including themes, descriptions, or the final report, to participants so that they can verify if the semi-polished findings depict what they had intended them to (Creswell, 2014). Member checking was done with the participants who were interviewed. A check for code "drifting," and peer debriefing was also done. Creswell (2014) states that to promote trustworthiness the researcher must, "make sure that there is not a drift in the definition of codes…This can be accomplished by constantly comparing data with the codes and by writing memos about the codes and their definitions" (p. 203). A drift in the meaning of codes will result in false findings because it would skew code counts and theme counts, which would ruin the analysis. Additionally, peer debriefing is the process in which a person, who is outside of the research helps to make sure it is understandable. The peer debriefer locates him or herself through stating his or her worldview and biases, reviews the study, and poses questions so that the research will resonate with other people aside from the researcher. Hence, peer debriefing, a check for drifting codes, and member checking were used to make sure that the qualitative findings were valid.

Other strategies were needed to make the quantitative section of the research reliable. Unfortunately, the sample size for the survey was too small to make generalizable statements as a result of decreased student participation in the programme. However, the processes involving developing the survey and survey distribution were done with thorough consideration for validity. To reduce the risk of participants wishing to please their ILA mentors with their survey responses, mentors and other ILASP staff were outside of the room when the researcher gave the surveys to the students. This also kept the process of administering surveys consistent between the various sites as there was no need to train others in how to present the surveys to the students. The survey had several Likert items to make it easier to determine the overall perceptions of the participants. In doing so, the survey instrument was made more reliable.

Results

Participant Demographics

All of the 13 students who attended and completed the ILA After-School Project (from the sites in Dartmouth, Halifax, Sydney, and Truro) were given consent forms and 11 students were given affirmative parental consent to participate in the survey. Those 11 students all responded to the survey, 4 of whom underwent face-to-face interviews with the researcher. Due to the fact that there was less than the expected number of students in the after-school programme, certain participant demographics will not be disclosed to maintain anonymity of the students in the study. There were 5 males and 6 females who responded to the survey from across the 4 sites, 2 males and 2 females were selected for interviews. Six students who responded to the survey were in 8^{th} grade, making that the grade of majority. A little over half of the population surveyed had been in the programme for more than 2 years.

The students who were interviewed represented various perspectives: one student had a negative attitude toward STEM, another a positive attitude toward STEM and 2 students with attitudes that were representative of the group, based on the survey results. Students' attitudes toward STEM were deemed negative or positive if their responses to Likert items were outliers. It was difficult to find a student who had responded with positive outliers to survey items, however, the survey made it clear that a students was bordering the positive outlier region and that student was selected for an interview along with 2 students who expressed views close to the majority.

Quantitative results

Frequency distribution.

Table 4.2.1: *Frequency distributions for each Likert item.*

M=missing, SD=Strongly Disagree, D=Disagree, N=Neither Disagree nor Agree, A=Agree, SA= Strongly Agree

	M	SD	D	N	A	SA
Before starting the ILA-ASP I enjoyed STEM.	0	0	2	1	6	2
Students should learn about STEM in high school.	0	0	1	1	4	5
The ILA-ASP made me want to go to college or university to take a STEM course(s).	0	0	2	5	1	3
I do not think STEM is of great importance to a country's development.	0	5	3	2	1	0
The hands-on activities offered by the ILA-ASP helped me to enjoy STEM.	0	0	1	0	2	8
I do not think STEM is useful for solving the problems of everyday life.	0	1	6	3	0	1
Before going to the ILA-ASP I did not want to have a job in a STEM field.	0	0	4	5	2	0
I would like to go to college or university to take non-STEM course(s).	0	0	4	2	2	2
I think STEM is of great importance to a country's development.	0	0	1	1	7	2
Before going to the ILA-ASP I did not think I was able to work toward a job in STEM.	0	0	6	3	2	0
I think STEM is useful for solving the problems of everyday life.	0	1	1	2	4	3
I would not like to go to college or university.	0	5	4	1	1	0
Before going to the ILA-ASP I wanted to have a job in a STEM field.	0	1	4	4	1	0
The ILA-ASP did not make me want to take STEM course(s) in high school.	0	1	4	4	1	0
The ILA-ASP made me think STEM is important in most of today's jobs.	0	0	1	2	6	2
I do not think I can do well in STEM courses.	0	1	4	3	2	1
After going to the ILA-ASP I wanted to have a job in a STEM field.	0	1	2	2	6	0
Students should not learn about STEM in high school.	0	3	5	1	1	0
The ILA-ASP helped me to think STEM is of great importance to a country's development.	0	0	1	1	8	1
There is a great need for STEM in most of today's jobs.	0	0	1	0	5	4
I would like to go to college or university to take STEM course(s).	0	1	1	4	5	0
Before going to the ILA-ASP I thought I could do well in STEM courses.	1	0	1	3	6	0
Before going to the ILA-ASP I did not enjoy STEM.	1	0	4	3	3	0
The ILA-ASP made me think that STEM is useful for solving the problems of everyday life.	1	0	1	3	5	1
Before going to the ILA-ASP I thought I would be able to work toward a job in a STEM field.	0	1	2	2	6	0
After attending the ILA-ASP I thought I could do well in STEM courses.	1	0	0	3	7	0
The ILA-ASP has made me want to take more than the needed amount of STEM course(s) in high school.	2	0	1	4	4	0
There is little need for STEM in most of today's jobs.	0	4	4	2	1	0
After attending the ILA-ASP I believed I could work toward a job in a STEM field.	0	0	0	4	7	0
Before going to the ILA ASP I did not think I could do well in STEM courses.	1	0	5	4	1	0
The ILA-ASP influenced me to think students should learn about STEM in high school.	0	0	1	0	7	3

Of the 31 Likert items which comprised the survey there were 8 items which were missing a response from a student and another item which two students did not respond to. Some of the notable items from the survey are those that the students responded almost unanimously towards. Table 4.2.2 shows the Likert items which had the greatest percent of students' agreement, with the *Agree* column representing the combined percent of the strongly agree and agree responses. While *Disagree* represents the combined percent of disagree and strongly disagree. The last item in the table provides invaluable demographic information, indicating that the majority of students in the ILA-ASP already enjoyed STEM before attending the programme.

Table 4.2.2*: Likert items showing highest percent agreement and disagreement.*

	Response Percentage		
	Agree	*Neither Disagree Nor Agree*	*Disagree*
The ILA-ASP influenced me to think students should learn about STEM in high school.	90.91	0	9.09
The hands-on activities offered by the ILA-ASP helped me to enjoy STEM.	90.91	0	9.09
I would not like to go to college or university.	9.09	9.09	81.82
There is little need for STEM in most of today's jobs.	9.09	18.18	72.73
Before starting the ILA After-school programme I enjoyed STEM.	72.73	9.09	18.18

The survey also included a non-Likert, non-demographic question. This question provided participants with a list of activities and asked them to indicate all of the STEM related activities that the ILA made them want to engage in at home. The list included watching STEM TV shows, visiting STEM websites, doing at home experiments, reading STEM related books or other. The results showed that 73% of students wanted to engage in at home experiments because of their involvement with the ILA, while the other categories were selected by 27% of students or less, indicating that the majority of ILA participants want to do at home experiments.

Cross tabulations.

A cross tabulation analysis was done to determine whether or not those who had participated in the programme for a longer period of time were more inclined to respond: 1) that the ILASP influenced them to pursue STEM classes in their academics; 2) that the ILASP has influenced them to aspire to STEM careers. Table 4.2.3 and Table 4.2.4 show the results of the respective cross tabulations. It is noteworthy that the responses of the students with low attendance was split in half between agreeing with and disagreeing with the statement that the ILASP influenced them to aspire to STEM careers. A possible reason why students with higher attendance were more inclined to agree that the ILA influenced them to aspire to STEM careers, could be that they were able to experience more STEM activities and learn about more STEM careers, making it easier for them to identify with a STEM job they would enjoy.

Table 4.2.3: *Cross tabulation of attendance and students' responses to: The ILA did not make me want to take STEM course(s) in high school.*

		Students' Attendance		
		High (≥ 2 yrs)	Low (< 2 yrs)	Total
Responses	Strongly Disagree	1	0	1
	Neither Disagree Nor Agree	2	2	4
	Agree	2	1	3
	Strongly Agree	1	0	1
Total		6	3	9

Table 4.2.4: *Cross tabulation of attendance and students' responses to: After going to the ILA after-school programme I wanted to have a job in a STEM field.*

		Students' Attendance		Total
		High (≥ 2 yrs)	Low (< 2 yrs)	
Responses	Strongly Disagree	0	1	1
	Disagree	1	1	2
	Neither Disagree nor Agree	1	0	1
	Agree	4	2	6
Total		6	4	10

Cronbach's alpha.

The responses to Likert items were analyzed with a Cronbach's Alpha test to calculate the internal consistency of the scores. The Cronbach's Alpha was 0.935, indicating excellent consistency (DeVellis, 2012). Based on the Alpha test, I can conclude that this survey was constructed well and it may be used in future research.

Table 4.2.5*: Cronbach's Alpha results for ILA Perceptions Scale.*

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.935	.937	22

Table 4.2.6: *Item-Total Statistics for ILA Perceptions Scale.*

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Students should learn about STEM in high school.	.935	.925
The ILA-ASP made me want to go to college or university to take a STEM course(s).	.587	.932
I do not think STEM is of great importance to a country's development.	.941	.926
The hands-on activities offered by the ILA-ASP helped me to enjoy STEM.	.759	.929
I do not think STEM is useful for solving the problems of everyday life.	.275	.936
I think STEM is of great importance to a country's development.	.975	.925
I think STEM is useful for solving the problems of everyday life.	.468	.937
I would not like to go to college or university.	-.221	.946
The ILA-ASP did not make me want to take STEM course(s) in high school.	.847	.928
The ILA-ASP made me think STEM is important in most of today's jobs.	.768	.929
I do not think I can do well in STEM courses.	.605	.932
After going to the ILA-ASP I wanted to have a job in a STEM field.	-.068	.945
Students should not learn about STEM in high school.	.932	.927
The ILA-ASP helped me to think STEM is of great importance to a country's development.	.932	.927
There is a great need for STEM in most of today's jobs.	.941	.926
I would like to go to college or university to take STEM course(s).	.420	.934
The ILA-ASP made me think that STEM is useful for solving the problems of everyday life.	.722	.930
After attending the ILA-ASP I thought I could do well in STEM courses.	-.123	.938
The ILA-ASP has made me want to take more than the needed amount of STEM course(s) in high school.	.187	.937
There is little need for STEM in most of today's jobs.	.975	.925
After attending the ILA-ASP I believed I could work toward a job in a STEM field.	.923	.932
The ILA-ASP influenced me to think students should learn about STEM in high school.	.975	.925

The Cronbach's Alpha would increase if the following items were omitted from the scale:

- The ILA-ASP made me want to take more than the needed amount of STEM course(s) in high school;
- After attending the ILA-ASP I thought I could do well in STEM courses;
- I think STEM is useful for solving the problems of everyday life;
- I would not like to go to college or university;
- After going to the ILA-ASP I wanted to have a job in a STEM field.

If this scale were used in the future these items may be rephrased or omitted altogether to increase the internal consistency of the scale, however, none of these items were omitted for this study as only frequency data is presented because of the small sample size.

Central tendency and interquartile range.

To get a sense of central tendency for each Likert item the median is displayed along with the interquartile range (IQR) in Table 4.2.7. The IQR is included as it describes the variance in the middle 50% of data. It is found by sorting data numerically from low values to high values and then subtracting the value at the first quartile from the value at the third quartile (McGraw, 2004). For positively worded statements the values under the median represent the following 1= Strongly Disagree, 2= Disagree, 3= Neither Disagree Nor Agree, 4 = Agree, and 5 = Strongly Agree. An example of a positively worded Likert item would be, students should learn about STEM in high school, which has a median of 5, indicating that when the responses were ordered numerically the middle response was Strongly Agree. The inverse is true for negatively worded statements, where 1 = Strongly Agree, 2 = Agree… and 5 = Strongly Disagree. An example of a negatively worded statement is, students should not learn about STEM in high school, which has a median of 4, meaning that the middle response was Disagree. The negatively worded statements are bolded in Table 4.2.7.

Table 4.2.7*: Median and interquartile range for all Likert items.*

For positively worded statements 1= Strongly Disagree and 5 = Strongly Agree, for negatively worded statements 1 = Strongly Agree and 5 =

	Median	IQR
Before starting the ILA-ASP I enjoyed STEM.	4	2
Students should learn about STEM in high school.	5	1
The ILA-ASP made me want to go to college or university to take a STEM course(s).	3	2
I do not think STEM is of great importance to a country's development.	4	1
The hands-on activities offered by the ILA-ASP helped me to enjoy STEM.	5	1
I do not think STEM is useful for solving the problems of everyday life.	4	0
Before going to the ILA-ASP I did not want to have a job in a STEM field.	3	1
I would like to go to college or university to take non-STEM course(s).	2	2
I think STEM is of great importance to a country's development.	4	1
Before going to the ILA-ASP I did not think I was able to work toward a job in STEM.	4	1
I think STEM is useful for solving the problems of everyday life.	4	3
I would not like to go to college or university.	4	2
Before going to the ILA-ASP I wanted to have a job in a STEM field.	3	1
The ILA-ASP did not make me want to take STEM course(s) in high school.	4	1
The ILA-ASP made me think STEM is important in most of today's jobs.	4	1
I do not think I can do well in STEM courses.	4	1
After going to the ILA-ASP I wanted to have a job in a STEM field.	4	2
Students should not learn about STEM in high school.	4	0
The ILA-ASP helped me to think STEM is of great importance to a country's development.	4	0
There is a great need for STEM in most of today's jobs.	4	1
I would like to go to college or university to take STEM course(s).	4	1
Before going to the ILA-ASP I thought I could do well in STEM courses.	4	1
Before going to the ILA-ASP I did not enjoy STEM.	3	2
The ILA-ASP made me think that STEM is useful for solving the problems of everyday life.	4	1
Before going to the ILA-ASP I thought I would be able to work toward a job in a STEM field.	4	1
After attending the ILA-ASP I thought I could do well in STEM courses.	4	0
The ILA-ASP has made me want to take more than the needed amount of STEM course(s) in high school.	3	1
There is little need for STEM in most of today's jobs.	4	1
After attending the ILA-ASP I believed I could work toward a job in a STEM field.	4	0
Before going to the ILA ASP I did not think I could do well in STEM courses.	3	1
The ILA-ASP influenced me to think students should learn about STEM in high school.	4	1

For statements with an interquartile range equal to zero (such as, students should not learn about STEM in high school) the respondents within the first and third quartile were in unanimous agreement with the median value, and because the interquartile range spans 50% of the respondents it is also indicative that at least 50% were in agreement. The statement “I think STEM is useful for solving the problems of everyday life” had an interquartile range of three indicating that students’ responses were quite mixed with regards to this question.

The interquartile range was also used to determine students whose responses were outliers, which was valuable for selecting students to be interviewed. According to McGraw (2004), an outlier “…is a data value that lies more than 1.5 times the interquartile range above P_{75} [third quartile value] or below P_{25} [first quartile value]” (p. 512). Certain students were consistent outliers below the first quartile for positively worded statements and above the third quartile for negatively worded statements. For instance a student responded with a 3 to I think STEM is of great importance to a country’s development. This student’s response was an outlier to the positively worded statement, in which other students showed strong agreement, at the same time this students’ responses to other statements were close to being outliers as well. It was difficult to find outliers showing stronger agreement to positively worded statements than their peers by using the IQR. However, I was able to use the IQR to select students for the interview stage who were representative of the group.

Qualitative results

The four students who were selected to undergo interviews chose the following aliases which have no affiliation to their real names: “Javon”, “Ms. No”, “Smith”, and “Lezlie”. Each case is entitled with the respective student’s alias. A brief description of students’ interview responses will be provided for each case along with the codes that resulted from that particular interview. The student's rendition of a scientist is included in their case, as well.

Javon: Hoop dreams.

Javon's survey responses showed he had some negative perceptions of STEM, which was primarily why he was chosen for an interview. The interview revealed that his negative disposition towards STEM was based on experiences he had of STEM being "boring." When asked what he would want to be if he could be anything in the world his response was the stereotype: He wanted to be an, "NBA player." Not surprisingly, when asked who one of his role models is he named a Canadian NBA player. Javon's illustration of a scientist revealed more stereotypes as he drew a white-male, Einstein look-alike, seen in figure 1.

Figure 1*: Javon's depiction of a scientist.*

In spite of his stereotypical aspiration and perceptions of a scientist, Javon expressed authentic approval of the ILA programme, which was based on his enjoyment of hands-on activities. He did not enjoy doing activities at the ILA that were not hands-on and STEM related; he says he dislikes it "when we go over who should be captain or something we wasted time on that." Javon provided insight into how the ILA can help students excel in STEM, which along with the other students' advice is included in the recommendations section. He expressed an understanding that one's ability to learn STEM, "depends on the kinds of teacher who teaches it."

Table 4.3.1: *Codes from Javon's survey.*

Codes	Definition	Count
I can do STEM job	This code is used when a student expresses the belief that she or he can do a STEM job. *This code does not necessarily mean that the student wants a STEM job.*	1
I want a STEM job (secondary pick)	This code is used when a student expresses a desire to have a STEM job (either as their main pick or secondary pick).	1
White Scientist	Used whenever a student expresses a perception of a scientist being White.	1
+ mentor relationship	Used when a student speaks of his/her mentor in a positive way.	1
Scaffolding	Is used when students speak positively about learning in steps, having a teacher break down a concept into easier bits to understand, based on the teacher knowing their students strengths and weaknesses.	1
Not doing STEM at ASP	Used when students share about non-STEM activities that take place at the ASP.	2
STEM success depends on teacher	Used when students claim that they need a good teacher to excel in STEM.	3
Dislike Boring STEM/ASP	Used when student says he/she dislikes when STEM or the ASP is boring.	4
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	7

Based on a classical content analysis of the emergent codes, it is clear that being exposed to hands-on science as opposed to "boring" science is of the utmost importance to Javon. This is a common theme throughout his interview and is highlighted when Javon explains his choice of favourite teacher is based on the fact that said teacher "does a lot of hands-on…"

Ms. No: Love/hate relationship.

Ms. No has a love/hate relationship with STEM, one of her survey responses was an outlier as it displayed a positive attitude toward STEM, yet some of her other responses were clearly reflecting a negative attitude toward STEM; for this reason Ms. No was selected for an interview. She loves STEM when it is presented in a fun way and she believes that it “opens up new ideas” in her mind. She hates STEM because she is not good at some of it and because she says with disappointment, in “regular science classes we don’t do hands-on experiments... it’s like things we’re working on in science now we did in 6th and 7^{th} grade.” Her favourite thing to do at the ILA is “listen to music” and her favourite ILA activity was a hands-on experiment on density.

She aspires to be a “car engineer” and she was influenced to see herself in this field because of a commercial she saw on TV. Ms. No’s depiction of a scientist is Marie Curie, a famous female scientist. She was inspired to draw Mme. Curie because of a project she did in school and because she “like[s] her work on the isotopes.” Ms. No. said she did not draw a black scientist because she does not “…really know that much Black scientist.”

Figure 2*: Ms. No's depiction of a scientist.*

Table 4.3.2: *Codes from Ms. No's survey.*

Codes	Definition	Count
I can do STEM job	This code is used when a student expresses the belief that she or he can do a STEM job. *This code does not necessarily mean that the student wants a STEM job.*	1
I want a STEM job	This code is used when a student expresses a desire to have a STEM job (either as their main pick or secondary pick).	1
White Scientist	Used whenever a student expresses a perception of a scientist being White.	1
Female Scientist	Used when a student expresses that a scientist can be male or female	1
Make STEM fun	Used when students attribute fun STEM to a positive STEM experience (enjoying an activity), or even success in STEM (learning it better).	1
Not doing STEM at ASP	Used when students share about non-STEM activities that take place at the ASP.	1
Watch videos	Used when student expresses a desire to learn STEM through videos	2
Learned something new	Used when students speak positively about learning a new concept.	3
Scaffolding	Is used when students speak positively about learning in steps, having a teacher break down a concept into easier bits to understand, based on the teacher knowing their students strengths and weaknesses.	3
+ STEM not influenced by ILA	refers to when students have positive STEM aspirations, which arise from other sources ex. TV, School, Parents... etc.	3
Dislike Boring STEM/ASP	Used when student says he/she dislikes when STEM or the ASP is boring.	4
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	7

For Ms. No, some of the main themes were an affinity for hands-on science, dislike for "boring" STEM, the desire and enjoyment of learning something new, an appreciation for scaffolding, and that she had positive STEM experiences outside of the ILA, which the researcher believes are supplemented by the ILA. Unique to Ms. No was her endorsement of learning STEM from watching science videos, she is particularly interested in watching "how engines are made."

Smith: Strong sense of identity.

Smith's survey responses presented a positive attitude and appreciation for STEM, yet Smith expressed no desire to pursue STEM academics or to enter into a STEM career, and for this reason Smith was selected for an interview. The interview revealed that Smith has a strong sense of herself and she is already on a career path for something she enjoys and excels in, which is not STEM related. Nonetheless, Smith was able to recount in detail, moments she had enjoyed the ILA, including the activity in which students "tested the strength of all the acids" and the demonstration she describes as when they "took a candle, we put it on a paper plate… there was water in the plate… we put like a some sort of a flask or something on top of the candle and all the water got sucked up into the flask." Smith later went on to give an explanation for the phenomenon she witnessed. She mentioned that the only thing she disliked about the ILA was when experiments she had done the year before with the ILA were repeated again.

Smith's depiction of a scientist was gender neutral and when asked why she made her illustration that way she responded "Because like a scientist can be gender neutral like there doesn't have to be like stereotypically for guys or girls." Smith's illustration is found in Figure 3.

Figure 3*: Smith's depictions of a scientist.*

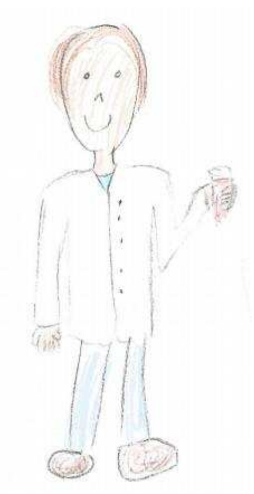

Table 4.3.3*: Codes from Smith's survey.*

Codes	Definition	Count
I can do STEM job	This code is used when a student expresses the belief that she or he can do a STEM job. *This code does not necessarily mean that the student wants a STEM job.*	1
+ STEM not influenced by ILA	refers to when students have positive STEM aspirations, which arise from other sources ex. TV, School, Parents... etc.	1
White Scientist	Used whenever a student expresses a perception of a scientist being White.	1
Female Scientist	Used when a student expresses that a scientist can be male or female	1
Dislike Boring STEM/ASP	Used when student says he/she dislikes when STEM or the ASP is boring.	1
STEM success depends on teacher	used when students claim that they need a good teacher to excel in STEM	1
Make STEM fun	Used when students attribute "fun STEM" to a positive STEM experience (enjoying an activity), or even success in STEM (learning it better).	2
Learned something new	Used when students speak positively about learning a new concept.	2
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	4

For Smith the most common themes were a positive attitude towards hands-on science noted by her confident reply to why she liked a certain experiment, "I liked it 'cause it was more hands-on teaching, instead of just kind of looking at things and learning from listening." She went on to mention she enjoyed that particular experiment because "it was something I never learned before."

Lezlie: Not a quitter.

One of the students who possessed a very positive attitude toward STEM was Lezlie: His survey revealed that he thoroughly enjoyed STEM, and had aspirations of pursuing a STEM career. Our interview enabled a deeper exploration of his aspirations, bringing to light current challenges Lezlie not only faces but is very cognizant of. Lezlie shared his struggles in a math course that he needs to pass, in order to be streamed into the actual course he needs, as a prerequisite to the STEM courses that he would have to take in his postsecondary studies. For this reason, when Lezlie was asked if he agrees or disagrees with the statement that anyone can be a scientist he immediately replied "I agree," however, when asked if he agrees that he could be a scientist, he was more hesitant, responding "Maybe… in the future yeah." When discussing the course route needed for Lezlie to pursue his desired STEM career he states, "It's going to be hard to get to calculus." Fully aware of the work needed to pursue his dream, Lezlie conveyed determination to do his best. Lezlie's depiction of a scientist yielded an image of a man with a blue and pink face because his scientist "drank some stuff." When asked what colour his scientist was before he "drank some stuff" Lezlie replied tan and when asked what race his scientist was he said he could be "…a White person, a Black person or Mexican." Lezlie's illustration of a scientist is found in figure 4.

Figure 4: *Lezlie's depiction of a scientist.*

Table 4.3.4: *Codes from Lezlie's survey.*

Codes	Definition	Count
White Scientist	Used whenever a student expresses a perception of a scientist being White.	1
+ mentor relationship	Used when a student speaks of his/her mentor in a positive way	1
I can do STEM job	This code is used when a student expresses the belief that she or he can do a STEM job. *This code does not necessarily mean that the student wants a STEM job.*	2
I want a STEM job	This code is used when a student expresses a desire to have a STEM job (either as their main pick or secondary pick).	2
Barrier to STEM	Used when students expresses something that prevents them from their desired STEM academics or STEM careers.	3
+ STEM not influenced by ILA	refers to when students have positive STEM aspirations, which arise from other sources ex. TV, School, Parents... etc	3
Make STEM fun	Used when students attribute "fun STEM" to a positive STEM experience (enjoying an activity), or even success in STEM (learning it better).	4
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	7

One of the major themes unique to Lezlie's interview was the barriers that he said were in the way of him pursuing his desired academic path and career. The most common theme in Lezlie's interview was hands-on science, which he strongly believes will draw more students to the ILA. He says the ILA should "…have them come to it for a day and do experiments." Another major theme in the interview was the role Lezlie's father played in helping him to appreciate STEM at a young age. Lezlie gave credit to a few people who have helped him to enjoy STEM and he promptly named his ILA mentor when asked who one of his role models is.

Comparing cases.

There were several similarities among the cases, particularly within the students' perceptions of a scientist and within the codes. Comparing the students' images, it is evident that none of the students drew a Black scientist and while some of the students did not draw the stereotypical male scientist, three of the students drew the stereotypical scientist in a lab coat. Three of the images also contain scientists holding something, which is another indication of the interviewees' emphasis on hands-on science. The images are placed side by side in figure 5.

Figure 5: *All of the interviewees' depictions of scientists.*

Tallying the codes from each case shows some of the common themes that were among all interviews. These common themes are highly significant, due to the fact that the selected students' survey results showed that they had varying attitudes towards STEM. Table 4.3.5 shows all of the codes from the four cases, along with codes from images, and their total count within all the cases.

Table 4.3.5: *Total codes from all interviews and pictures.*

Codes	Definition	Count
Female Scientist	Used when a student expresses that a scientist can be male or female	2
+ mentor relationship	Used when a student speaks of his/her mentor in a positive way.	2
Watch videos	Used when student expresses a desire to learn STEM through videos	2
Barrier to STEM	Used when students expresses something that prevents them from their desired STEM academics or STEM careers.	3
Not doing STEM at ASP	Used when students share about non-STEM activities that take place at the ASP.	3
I want a STEM job	This code is used when a student expresses a desire to have a STEM job (either as their main pick or secondary pick).	4
White Scientist	Used whenever a student expresses a perception of a scientist being White.	4
Scaffolding	Is used when students speak positively about learning in steps, having a teacher break down a concept into easier bits to understand, based on the teacher knowing their students strengths and weaknesses.	4
STEM success depends on teacher	Used when students claim that they need a good teacher to excel in STEM.	4
I can do STEM job	This code is used when a student expresses the belief that she or he can do a STEM job. *This code does not necessarily mean that the student wants a STEM job.*	5
Learned something new	Used when students speak positively about learning a new concept.	5
+ STEM not influenced by ILA	refers to when students have positive STEM aspirations, which arise from other sources ex. TV, School, Parents... etc.	7
Make STEM fun	Used when students attribute "fun STEM" to a positive STEM experience (enjoying an activity), or even success in STEM (learning it better).	7
Dislike Boring STEM/ASP	Used when student says he/she dislikes when STEM or the ASP is boring.	9
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	28

The predominant code throughout all of the interviews and images was “hands-on.” The reoccurrence of this code in interviews with students who have more negative attitudes towards STEM and within interviews with students who show appreciation for and enjoyment of STEM, indicates that the hands-on activities offered by the ILA are helping a wide-range of students to enjoy STEM.

Some of these activities include advanced STEM content such as the activity in which 7th grade ILA students make a pinhole camera. In this lesson, students learn about cameras; how the human eye works; and the properties of light, including how photons travel and how they are reflected (Imhotep’s Legacy Academy, 2014). The lesson, the process of making a pinhole camera, and utilizing the pinhole camera, require students to engage in math, engineering, technology, physics, chemistry, and biology. The hands-on aspect of building the camera and using it, coupled with the integrated STEM content, enable students to better understand the concepts they are taught. This activity is typical of how the ILA integrates content from STEM subjects in all their lessons, as well as, how the ILA challenges learners to design. To accompany this lesson ILA mentors may have an optometrist of African descent visit the after-school programme to discuss how the eye is like a camera, what an optometrist does, and how one becomes an optometrist. In 8th grade ILA participants are asked to create a steamboat that works, after learning about the energy conversions related to heat energy and drawing connections to the world around them. Similarly, in grade 9, ILA learners are given the opportunity to learn about magnetism, and Ohm’s law by making a motor. Whenever students make something in an ILA lesson they are encouraged to take it home, which is another aspect of the hands-on lesson that the participants enjoy (Imhotep’s Legacy Academy, 2014).

That said, students' dislike for "boring" STEM, described by the students as: taking notes, listening, and learning the same thing over and over again, supports their desire to learn by doing. On the few occasions the students expressed dislike for the after-school programme, their dislike was almost always linked to not doing hands-on activities, while the exception to this was when the student described doing the same hands-on activity the student had done in the prior year. This shows that students expect to have new hands-on science activities presented to them at the ILA after-school programme.

Students believe that making STEM fun will help them to enjoy science and to learn it better. The ILA succeeds in providing students with fun learning opportunities through lessons in which students get to: make slime; solve a case using crime scene investigation techniques; make an electroscope; and learn their blood type (Imhotep's Legacy Academy, 2014). Students also express the need for "scaffolding" to help them learn STEM better, which is when teachers break complex concepts into easier understood stages and present the stage that is just above the students' level of understanding. They also link their success in STEM to the ability of their teacher, simply put, their success depends on if they have a good teacher. Many of the students spoke about having positive STEM influences outside of the ILA, which have helped them to want to pursue STEM academics and STEM careers. The number of times the code for positive mentor relationships occurred was less than many of the other codes, however, for the students who spoke well of their mentor relationships, it is evident that their mentor has played a role in helping them to enjoy STEM.

Mixed Methods Results

Qualitative results informing quantitative results.

The survey was instrumental in determining participants who would provide distinct insights into the ILA. Students who personally did not consent for the survey because they quit the programme were a particular group of interest. The students at the Antigonish site had recently withdrawn from the programme and consequently made a point of not being in the survey; their particular views of the ILA and the circumstances that caused them to quit would undoubtedly be insightful for improving the ILA. Thus, after an amendment was made, the researcher invited the students who quit to take part in a focus group to understand their perspectives. Unfortunately, the students declined. Still seeking to understand the problems at that site, the researcher asked for permission to interview one of the teachers at that site, who worked closely with that group of students, permission was declined by the ILA as the study was meant to be on students' perceptions, and as a result, no further amendments were put forward to the study. Nonetheless, the results of the survey helped the researcher to select 4 students with varying perspectives, who were able to provide detailed insight into their ILA experiences.

Comparing the quantitative data with the qualitative data showed a great degree of consistency between the top percent agree Likert items and reoccurring codes. The Likert item, the ILA-ASP influenced me to think students should learn about STEM in high school had 90% agreement from the students who replied to the survey. The students who were interviewed did not explicitly reiterate this idea, however, they took this idea a step further by providing a number of codes on how students can learn and enjoy STEM better, thus supporting their view that students should learn about STEM in high school. The codes that are related to how students can learn STEM better include watch videos, barrier to STEM, scaffolding, STEM success depends on teacher, learned something new, make STEM fun, dislike boring STEM/ASP, and hands-on. If these codes were categorized under an umbrella code called "improving STEM education," the total count for that code would be 62. It is remarkable to note that in 4 half hour interviews, students commented on how to better their and their peers' engagement and understanding of STEM 62 times.

Table 4.4.1: *Percent agreement to the ILA-ASP influenced me to think students should learn about STEM in high school.*

	Response Percentage		
	Agree	*Neither Disagree Nor Agree*	*Disagree*
The ILA-ASP influenced me to think students should learn about STEM in high school.	90.91	0	9.09

Table 4.4.2: *Codes about improving STEM education.*

Codes	Definition	Count
Watch videos	Used when student expresses a desire to learn STEM through videos	2
Barrier to STEM	Used when students expresses something that prevents them from their desired STEM academics or STEM careers.	3
Scaffolding	Is used when students speak positively about learning in steps, having a teacher break down a concept into easier bits to understand, based on the teacher knowing their students strengths and weaknesses.	4
STEM success depends on teacher	Used when students claim that they need a good teacher to excel in STEM.	4
Learned something new	Used when students speak positively about learning a new concept.	5
Make STEM fun	Used when students attribute "fun STEM" to a positive STEM experience (enjoying an activity), or even success in STEM (learning it better).	7
Dislike Boring STEM/ASP	Used when student says he/she dislikes when STEM or the ASP is boring.	9
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	28
Improving STEM education	When students speak positively about methods that could be used to improve STEM education.	**62**

Additionally, there was great overlap between the Likert item, "The hands-on activities offered by the ILASP helped me to enjoy STEM," and the interviews. In the survey 90% of students agreed that the hands-on activities offered by the ILASP helped them to enjoy STEM, while hands-on was the most numerous code. Table 4.4.3 and Table 4.4.4 show the respective percent agreement for the Likert Item and the code count for hands-on.

Table 4.4.3: *Percent agreement to the hands-on activities offered by the ILA-ASP helped me to enjoy STEM.*

	Response Percentage		
	Agree	*Neither Disagree Nor Agree*	*Disagree*
The hands-on activities offered by the ILA-ASP helped me to enjoy STEM.	90.91	0	9.09

Table 4.4.4: *Count for the Hands-on Code.*

Code	Definition	Count
Hands-on	This refers to when students speak positively about hands-on science or when they describe an activity which is hands-on positively.	28

The interviews were able to elucidate why hands-on teaching was so effective for students to learn STEM. The interviewee Smith, speaking about a certain activity, stated, "I liked it cause it was more hands-on teaching, instead of just kind of looking at things and learning from listening." In her comment, she places hands-on learning above, learning from watching and learning from listening, which seem to be other learning styles Smith has been exposed to that have not worked for her. This idea is echoed by Ms. No who, when speaking of understanding concepts, argues, hands-on teaching enables students to "fully understand it… than just writing it down and not fully understanding it." For Ms. No, hands-on teaching gives her a better grasp of what she is trying to learn, or as she puts it, a fuller understanding. When asked about traits of a good teacher Javon replied with describing one who does "more hands-on" activities and when Lezlie was questioned about how to get more students to attend the ILA, his response was to have them attend a session where they get to "do experiments." For Lezlie, hands-on science was a way to attract students to STEM and peak their interest in STEM and for Javon, hands-on STEM was simply good pedagogy.

The Likert item, "Before starting the ILA ASP I enjoyed STEM" had a high percentage of students who agreed with that statement, indicating that the majority of students attending the ILA already liked STEM. The code, "+ STEM not influenced by ILA," helps to explain why that may be the case because based on the interviews, three quarters of the students interviewed already had positive STEM experiences with their parents, or from watching TV, or from a good class in a STEM subject. These positive STEM experiences have impacted two of these students to the extent that a STEM job is their primary pick for a future occupation, while for the third student it is a secondary pick. For the student, Javon, who did not express having positive STEM experiences that were both influential enough to make him desire a STEM job and that were external to the ILA, the other codes within his interview showed that the ILA has been fostering an attitude of appreciation for STEM in him through having a positive relationship with his mentor and through experiencing hands-on science. Students like Javon, who are not getting the STEM support from other sources rely on the ILA to provide them with a quality STEM learning environment, an understanding of STEM careers that are available to them and the courses that they would need to take to work towards those careers, and a safe place to ask questions that they may have about STEM. The ILA has helped Javon to enjoy STEM, and although his dream is to be an NBA player his secondary job aspiration is one in STEM, which if continuously nurtured by the ILA, may replace his hoop dreams.

Table 4.4.5: *Percent agreement to before starting the ILA ASP I enjoyed STEM.*

	% Agree	*% Neither*	*% Disagree*
Before starting the ILA ASP I enjoyed STEM.	72.73	9.09	18.18

Table 4.4.6: *Code count for + STEM not influenced by the ILA.*

Codes	Definition	Count
+ STEM not influenced by ILA	refers to when students have positive STEM aspirations, which arise from other sources ex. TV, School, Parents... etc.	7

Major inferences.

The major inferences that were made from the quantitative phase of the study were that the hands-on activities offered by the ILA reached a wide array of learners and helped them to have positive STEM experiences; that students who attended the ILA for a longer time were more inclined to agree that the ILA influenced them to aspire to STEM careers possibly because they were able to experience more STEM activities and learn about more STEM careers, making it easier for them to find a STEM job they would enjoy; and the last inference is that the majority of students had positive perceptions of STEM because they were having positive STEM experiences both in and outside of the ILA.

The major inferences drawn from the qualitative phase of the study were that the students love hands-on STEM, they expect to have hands-on STEM activities at the ILA, and they attribute their best learning in STEM to whenever it is taught with hands-on science activities like the ones offered to them through the ILA. These activities involve learning about sight, density, displacement, gas movement from high to low pressure, properties of light, polymerization, hydraulics, current, etc… Some of these concepts are beyond the grade level the students are in, yet through the use of scaffolding and hands-on pedagogy students are able to "fully understand it." In spite of this, another major inference drawn from the qualitative phase of the study, is that ILA students still have difficulty envisioning a Black scientist instead of the stereotypical white scientist, which may be something that these students internalize on a subconscious level. This was expressed through almost half of the surveyed students' desire to not have a STEM job and through the interviewees' depictions of non-Black scientists.

The dominant meta-inference from this study is the need for the ILA to continue to use hands-on teaching, coupled with quality STEM lessons, to engage learners and nurture positive attitudes toward STEM. This is based on the unanimous views of all interviewed students and on ten out of the eleven surveyed students. The students clearly voiced their affinity for this type of teaching style and the students were able to defend why it works best for them.

There were two main transformative inferences that were drawn from the research process, as opposed to from the research results. Students for the most part, were willing to share their opinions on the programme and especially those who were selected for interviews, took their role as interviewee very seriously and provided several recommendations for the ILA. This leads me to believe that these students appreciated that they had a safe place to share and the power to share. They understood that we were working together, which is part of the aim for transformative research. The researcher believes that the students who did not participate in the study used their silence as a form of expressing power. Their actions and silence underline the issues and struggles that this marginalized group faces on a daily basis. There is not much else I can infer from their actions, however, it is clear that the students recognized that they had a choice to be in the survey. They exercised power by not acquiescing to participate even though almost all of the students at the other sites did. I am assuming that their actions were due to injustices at some level and I feel certain that their actions call for change. I only hope that the recommendations that came out of the other sites will be able to better serve the Antigonish site.

Discussion

Students' Perceptions: Hands-on STEM and Beyond

This research study revealed that many of the students who took part in the ILA after-school programme believed that the ILA influenced them to enjoy STEM and to view STEM in a more positive light. Several of the students enjoyed STEM prior to attending the ILA, and for several participants their academic choices and career aspirations were shaped by factors *external* to the ILA after-school programme. Nonetheless, the ILA supplements their STEM ambitions and for students who do not have future goals linked to STEM, the ILA provides a space where students can explore STEM in a way they desire.

Students' insights into teaching techniques and qualities of effective teachers resonate with other research. In particular, the desire of students in this study to engage in a hands-on approach to STEM was almost identical to that of Latino students who were involved in a similar study on their perceptions of chemistry (Renee, 2007). The alternative school where the study took place had a limited availability of laboratory equipment and lacked hands-on science activities. Through interviews and observations of 5 students, the researcher found that they, "all thought that providing more hands-on activities, even in the form of outreach programs, would help younger Latino students stay interested in science" (Renee, 2007, p. 722). This research study also found that one of the factors that caused student disinterest in science was a lack of hands-on activities. It is clear from studies on students' perceptions that students applaud the hands-on approach but this begs the question of whether or not there are other advantages to hands-on learning: What are the advantages to investigating and learning in a tangible way through building, experimenting, and using instruments, aside from student enjoyment?

In *Perspectives on Hands-on Science Teaching* (1994), authors Haury and Rillero recount a plethora of benefits that accompany the hands-on approach to STEM instruction. Some of the mentioned benefits are an increase in learning; an increase in students' motivation to learn; an increase in students' enjoyment of learning; an increase in skill proficiency, which includes communication skills; an increase in students' independent thinking and the ability of students to make decisions based on experimental evidence; and an increase in students' perception and creativity (Haury & Rillero, 1994). That said, Haury and Rillero (1994), praise the hands-on approach because it makes STEM fun for students and teachers alike, combatting students' anxiety and students' avoidance, which are often associated with STEM (Haury & Rillero, 1994).

As a way to spark students' attention and affection for STEM, hands-on STEM activities are essential for programmes like the ILA. The presentation of hands-on STEM can be refined to ensure that hands-on activities are minds-on activities, through the use of inquiry-based STEM approaches. Hands-on activities that follow a step-by-step process foster an erroneous concept about the nature of science in students' minds, as opposed to, inquiry-based activities where students design and apply their own investigations (Huber & Moore, 2010). Inquiry-based science education does justice to science as a process of discovery, through its emphasis on developing students' abilities to investigate, construct knowledge, and understand (Fang, Pringle, & Lamme, 2010). Numerous studies have shown that an inquiry-based approach to science education is superior to traditional approaches in developing both students' engagement in STEM and developing students' knowledge about STEM, as well as, in promoting the skills of inquiry and appropriate scientific habits of mind. (Chang, & Mao, 1999; Chen, Wang, Lin, Lawrenz, & Hong, 2014; Dalton, Morocco, Tivnan, & Mead, 1997; Wilson, Taylor, Kowalski, & Carlson, 2010).

Inquiry-based activities require students to pose a question; plan an investigation that will address that question; carry-out their investigation, collecting and interpreting data; and document and share their findings (Huber & Moore, 2010). Huber and Moore (2010) provide a model to help educators make the transition from hands-on STEM to hands-on inquiry based STEM. Their model involves, engaging students and directing inquiry through discrepant events; students' brainstorming the planning of investigations with educator support; educators providing suitable performance aids to give students structure and support; and the requirement that students share their research with their peers (Huber & Moore, 2010). The ILA is encouraged to develop and implement hands-on inquiry-based STEM activities to provide ILA participants with an experience in which they go beyond following in the footsteps of scientists to being scientists who carry-out authentic experiments.

Recommendations for the ILA

During the interview process it became obvious that students had several recommendations for improving the ILA. Their ability to provide relevant insight into the ILA after-school programme shows that they believe the ILA can and will implement the suggested changes. Students were able to identify key areas they enjoyed at the ILA, they were able to discuss their learning processes, including ways they learn best, and they were able to point out areas where the ILA could improve. The students readily identified characteristic they believe a good teacher must have. Through the research process the researcher was able to recognize ways the ILA could improve and through member checking with the students, the researcher was able to make further recommendations for the ILA.

Students' recommendations.

Synthesizing the data, the researcher interprets the students as recommending that the ILA should continue to…

1) Make STEM fun.

When asked why an interviewee enjoyed doing STEM at the ILA the response was simply, "they make it fun, they do experiments and stuff."

2) Use hands-on teaching.

When asked why a student liked a particular ILA activity, she succinctly replied, "I liked it cause it was more hands-on teaching, instead of just kind of looking at things and learning from listening."

Both recommendations 1) and 2) resonate with Haury and Rillero (1994) who comment that the use of hands-on science has been shown to increase the impetus for students to learn science.

3) Use scaffolding when explaining STEM.

When asked how the ILA helped a student to understand math better her reply was, "they help me understand it because they break it down into something I can comprehend." Scaffolding breaks down barriers students encounter in STEM, by enabling them to experience mini accomplishments in understanding a STEM concept, eventually leading to the full understanding of the given concept. This combats the effects of internalized racial oppression, in the form of the belief that a student cannot excel in STEM because the student is Black, which could occur from repeated failure to understand a concept presented in its entirety.

4) Promote positive mentor relationships.

An interviewee expressed that his mentor was his role model. However, three out of four interviewees did not know what their mentor was taking in school or what career their mentor was aspiring to. When asked about what their mentor wants to become a student replied, “we haven’t talked about it.” For a mentor to be a role model for the ILA students in STEM fields, it is imperative that the mentor makes it clear that she or he is taking STEM courses in university and going into the STEM workforce. According to Weber’s (2011) research, there is a link between exposure to role models and improved attitudes towards science. For the ILA to observe this connection mentors need to communicate to their students, the significance of STEM in their lives.

5) Promote all ILA programmes available to students.

An interviewee who is currently not taking a math course in the stream he needs, to become an engineer, suggested the ILA, “…have a mentor come in and tutor me.” Perhaps this student is unaware of the virtual school tutoring programme or perhaps this student does not have internet access at home. The ILA should arrange for students to have computer access in one of their classes after school, if any students require tutoring from the virtual school programme.

I interpret the students as recommending that the ILA needs to re-evaluate…

1) Giving students new hands-on activities.

If a student does ILA in grade 7 they should not have the same activities in grade 8 and 9. A student shares dissatisfaction, “there was some times I was put in with the grade 7s and 8s and I had to learn stuff I already learnt before." This may require the ILA to develop more activities or to have mentors present grade appropriate activities.

2) Allowing students to actually engage in the activity.

Mentors should not be the only one getting the hands-on experience. When speaking about a periscope activity Ms. No said her mentor made the periscope for her and she thought she could have made it herself. Essentially, this student's mentor denied her the chance to take part in the hands-on activity, preventing her from the experiential learning, which would have occurred if she was given the opportunity to fully participate in this activity. The mentor, who was in a position of power, exercised that power by not giving the student the opportunity to make the periscope. In doing so, the mentor sent an implicit message to the student, which was that the mentor did not think the student was capable. This is precisely the message that culturally responsive teaching is against. According to Codjoe (2006), the misconception that Black children are incapable, when internalized over time, will adversely affect their identity. Mentors must encourage their students to take risks, to participate, to try again; guiding them along the way, mentors must refrain from taking over, and they must remember to constantly tell their students they believe that the students *are* capable.

3) Teaching students about the achievement of Black Scientists.

None of the interviewees drew a Black scientist and when one student was asked why, her response was, "I don't really know that much Black scientists." This student's remark reveals a weak link between STEM and her cultural identity. In order to combat the Eurocentric curriculum that students encounter in schools, the ILA needs to ensure that mentors are teaching their students about the accomplishments of Black scientists. Research has shown that a strong sense of Black cultural identity affirms that students do not need to act White to succeed (Codjoe, 2006). If a strong sense of cultural identity can be fostered in relation to STEM, then these students will view STEM as an attainable career and when asked to draw a scientist, students would draw someone who looks like them.

4) Give the students in the robotics programmes more time to practice.

   "I think we should do more robotics to help us out in the future, to help us out at the competition, so we're not nervous." This statement indicates that students who take part in the robotics programme are doing so on a competitive level, as opposed to participating for fun. Therefore, they want to do their best at the competition and require more practice to do so.

Based upon the data analysis the researcher believes the students request that the ILA should…

1) Promote Imhotep at school science fairs.

   When asked how to recruit more members a student said, "We are having a fair thing at our school and I think that Imhotep should come to it or we should rep Imhotep at it and tell all the kids about."

2) Have mentors contact students' STEM teachers to learn the units that are being taught.

   When asked how the ILA could help a student in math the reply was, "I think if they probably get the work from my teacher it would help a lot." If mentors are aware of the units that are being taught they can focus their math tutorials on what students are currently learning.

3) Have students watch short videos on things that cannot be brought into the classroom.

   When asked if there was anything the student wanted to do at the ILA that they have not done the student replied, "We could watch a couple of videos of how engines are made."

4) Have a field trip to a science museum.

When asked what the ILA could do to help a student learn science better the student responded, “We can probably go to a science museum or something.”

5) Hire/train mentors to be comfortable and effective at communicating STEM with kids.

When asked why a student said she believed all students are capable of learning STEM but not all are willing to learn it, she retorted, “I don’t know… it’s probably not something that interests them or it’s not being presented to them in a very effective way.”

Directly quoting the students, I have compiled their description of the qualities of a good teacher.

1) “A teacher who won’t fool around…”
2) One who, “knows our strengths and weakness and she focuses more on our weaknesses and she builds up on our strengths about it.”
3) One who is, “really nice and kind-hearted.”
4) A teacher who knows their students and also relates well to them. “He understands a lot, cause he was like the same way I guess. So that’s better.”
5) One who uses differentiated instruction. “He does a lot of hands-on, a lot of it.”
6) One who, “if you don’t understand it, he’ll work one-on-one with you.”

Study's recommendations.

After concluding the data analysis of the four students’ perspectives, I agree with the students, who said the ILA should continue to…

1) Use hands-on science.

Data from this study showed that almost all of the students in the ILA praised the hands-on teaching methods used in the after-school programme. They spoke of how hands-on activities were more engaging and helped them learn, which is in accord with Haury and Rillero (1994), proponents of hands-on teaching methods, who believe these methods increase students' motivation to learn; and increase students' enjoyment of learning. The researcher concurs, advising that the ILA ensure that new hands-on activities are developed so students do not repeat the same activities, that each session have a hands-on STEM component, and that mentors allow the students to fully engage in the activity. The researcher posits that the results of this study indicate that hands-on STEM has been beneficial for students in the ILA and as such should continue.

2) Make STEM fun.

The code "Make STEM fun" occurred several times throughout the interviews marking its significance to the interviewees. When STEM is presented in a fun way it enables students to overcome anxiety that they may have with "harder" subjects (Haury & Rillero, 1994). The researcher encourages the ILA to continue to develop fun hands-on STEM activities to reduce students' anxieties and to provide them with a learning environment that they enjoy.

3) Use scaffolding to convey difficult concepts.

In each of the interviews, students spoke positively about scaffolding. They state that their learning increases when their teachers or mentors break concepts into steps and build on them as students reach the required level of understanding. Scaffolding is crucial because it gives students another chance to master the material if it was not grasped initially. If a student was not presented with scaffolding and the student did not understand the lesson the student could subconsciously nourish the idea that he or she is incapable of excelling in STEM, which would strengthen the effects of internalized racial oppression (Sensoy & DiAngelo, 2012). Scaffolding helps to ensure that students learn the concepts they are presented with and for that reason the ILA should continue to use this teaching technique.

4) Foster positive student-mentor relationships.

Studies have shown that validating the values of one's cultural group can aid minority students' STEM academic achievement (Kendricks, Nedunuri, & Arment, 2013, Weber, 2011). The ILA strives to nurture positive student-mentor relationships, however, students who were interviewed were unable to describe what their mentors were taking in school or what career their mentor was training to enter. The researcher recommends that the ILA continue to build bonds between mentors and participants so that the students recognize that not only do their mentors look like them but their mentors are also in STEM courses and on their way to STEM careers.

And I would add the following recommendations that go beyond the students' perspectives:

1) Take attendance and have make-up days.

   The low number of students from across the sites are indicators that the ILA needs to reach more students. I believe that attendance at each site should be monitored on a weekly basis, so that mentors, programme officers, the executive director and the board of directors are aware of how many students are actually attending.

2) Have "bring a friend" days.

   To increase the number of students attending the ILA the researcher suggests giving students an incentive for bringing a friend of African descent to the ILASP. Prior to these days the ILA should inform those who attend on a regular basis about the incentive and then on "bring a friend day" it is essential that the ILA have hands-on STEM activities presented to the students. Renee's (2007) research found that the use of hands-on STEM was an effective form of STEM outreach for Latino students in a disadvantaged neighbourhood. The researcher agrees that hands-on STEM would be effective for outreach based on the numerous benefits that are associated with it (Haury & Rillero, 1994).

3) Have weekly anonymous exit cards filled out.

The cards can ask the yes or no question: Did you like today's session? And why? This would allow the ILA to make necessary interventions before students leave the programme and get constant feedback on activities. At the same time, this would inform the ILA participants that their opinions matter. Emdin (2011a) has shown that when teachers value the voice of their students, they acquire social capital, creating a space where students are more willing to participate.

4) Accompany mentors' curricular content training, with how to be an effective culturally responsive teacher.

Wallace and Brand (2012) describe culturally responsive pedagogy as understanding the students' culture and facilitating learning to their needs. One of the needs shown from this study is that ILA participants do not view themselves as scientists. At best, it is something they view themselves as aspiring to. Mentors need to ensure that students know that they *are* scientists, by allowing students to conduct experiments themselves and by verbally reinforcing that the students are doing real science. As well, mentors need to work on counteracting stereotypes that link the students' culture to an inability to take part in STEM. Based on the survey there is a clear canyon in students' minds between STEM and the real world. The researcher believes that the effective use of culturally responsive pedagogy would help students to bridge that gap, the use of outdoor activities would also help students connect STEM with the world around them.

5) The Black scientist of the day.

As part of culturally responsive pedagogy it is advised that at the start of each session the ILA would have 10 minute segments on a particular Black scientist, when the mentors would explain to the students who the scientist is, what the scientist studied, and what the scientist did; in an engaging manner, by showing short video clips, having mentors act out skits, bringing in relevant items to show-and-tell etc. This would help to construct a strong sense of Black cultural identity which Codjoe (2006) found provided students with coping skills when faced with racism; countered the effects of devaluation of Blacks; and affirmed that students did not need to act White to succeed.

6) Develop take-home activities.

   Based on the students' survey results it is evident that the ILA has made its participants want to engage in at-home experiments. To continue to grow participants' affinity for STEM, the ILA could help them in their endeavour to experiment at home by developing mini experiments that relate to the ILA session, which students would take home after their regular ILA session.

7) Expand curricular content to include hands-on *inquiry-based* STEM activities.

   Numerous studies have shown that an inquiry-based approach to science education surpasses traditional approaches in engaging students, in developing students' knowledge, in promoting the skills of inquiry, and in nurturing the students' scientific habits of mind (Chang, & Mao, 1999; Chen, Wang, Lin, Lawrenz, & Hong, 2014; Dalton, Morocco, Tivnan, & Mead, 1997; Wilson, Taylor, Kowalski, & Carlson, 2010). The interviews reveal that students have not been exposed to inquiry-based STEM at the ILA. That said, the dominant codes for their fondness of hands-on STEM and their desire to learn something new, would both be satisfied through an inquiry-based approach to STEM, which would allow the learner to carry-out an authentic experiment.

Limitations

One of the major limitations to this study was that only 13 students were participating in the 4 sites and of the 13 only 11 students were in the study. For such a small total population I would need the entire population to respond to the survey to be able to make claims that the method the researcher used gives results that lie within a range or interval that spans the true population parameter for 95% of the samples (Moutinho, 2011). This statement cannot be made because the confidence intervals would be too great to make any claims of significance (Moutinho, 2011). For instance, the researcher could report that the average response to a question was neither but the interval that spans the true population parameter for 95% of respondents would be between disagree and agree because only 11/13 students responded. This limited the type of data analysis that could be done, which is why only frequencies, cross tabulations, and medians were reported.

In addition, another huge limitation to this study was the inability for research to occur at the Antigonish site. If their views were researched, they may have provided valuable insight into how the ILA could improve. Similarly, by the time this study was approved by the research ethics board, the First Lego League, robotics programme offered by the ILA, had finished. So, the perspectives of the students who attended the robotics programme but did not attend the ASP, were not heard. That group of students, however small it may be (less than 5 students) would have presented perspectives of a unique subgroup of ILA participants. Surely, learning those students' reasons for not joining the after-school programme would have been beneficial for the ILA.

Implications for Future Research

According to the research findings, the majority of students attending the ILA after-school programme already enjoyed STEM, when coupled with the fact that the attendance levels were so low (13 students from 4 sites), it is evident that the ILA needs to work on outreach strategies. Future research can be done on the ILA's development and implementation of outreach strategies. Research can also be done to understand the perceptions of students who do not attend the programme, in hopes of learning how the ILA can reach a broader audience.

The ILA has separate programming, the First Lego League, a robotics programme where students compete in teams to build a robot and race it on an obstacle course; and the virtual school programme, which is an online tutoring programme. These other programmes were not included in this study and naturally researching them in the future would better inform the ILA of its best practices and areas where it can improve. It would be interesting to see how either programme would offer refining techniques for the after-school programme and vice-versa. In all of these programmes the ILA aims to have Black mentors who are currently enrolled in an undergraduate or graduate STEM field. This study did not research the mentor-student relationships in depth. That said, students were asked if they knew the courses their mentors were taking in school and if they knew what career their mentor was working towards and only one of the interviewed students was able to provide a general field close to what the mentor was actually studying. This response prompted me to wonder about how effective the mentoring system was. A study on the effects of having Black mentors would be useful for the ILA to validate why they choose this approach to teaching Black learners STEM.

A longitudinal study would also be a topic of interest for future research. Particularly studying Javon's case would be very beneficial for the ILA because of his negative attitude toward “boring STEM.” Javon did not show any signs of having positive STEM influences outside of the ILA, which means that the ILA is where he enjoys STEM most and more importantly, the ILA’s role in his life will be a determining factor in whether he follows his hoop dreams or whether he pursues his secondary choice of a biology related STEM career. Learning how and why he would be influenced by the ILA to switch career aspirations, or not, would provide the ILA with an understanding of the challenges they face with the minority of students who attend the ILA and do not have positive STEM influences outside of the ILA. Javon’s case would also help the ILA to refine ways for recruiting more students.

Conclusion

Oppressive structures exist in the Nova Scotian education system through its non-inclusive curriculum, which neither acknowledges the achievements of minorities in STEM nor their presence in STEM careers (Minister's Panel on Education, 2014). Specifically, the underrepresentation of people of African descent in STEM, has deleterious effects on their learning, by supporting internalized racial oppression and stereotype threat. These effects are amplified by dominant ideologies, such as meritocracy, which serves to reinforce negative stereotypes. Poisoning the learner's will to study STEM, internalized racial oppression causes the African Nova Scotian learner to think excelling in STEM is unattainable because said learner has not seen anyone who looks like her or him in that field; while, stereotype threat causes the African Nova Scotian learner to underperform because of the anxiety felt to oppose the stereotype; and finally, meritocracy tells the African Nova Scotian learner that if you have not prevailed in STEM you simply have not worked hard enough, or if you did work hard, you are incapable of excelling, therefore, you should give up.

Culturally responsive STEM pedagogy counters the oppressive structures that arise from a monocultural curriculum, so that students within the minority group do not lose hope but can experience equitable learning experiences and bridge the existing disparities seen between White students and minorities in STEM subjects. For African Nova Scotian learners, culturally responsive pedagogy does not invalidate the achievements of Black leaders in STEM, nor does it hide their accolades. Instead, culturally responsive pedagogy embraces their contributions to the field through a culturally relevant curriculum. The ILA employs culturally relevant teaching, offering STEM based after-school programmes to students of African Nova Scotian descent, in an attempt to liberate them from the oppressive systemic structures they face in school. The ILA infuses the Nova Scotian curriculum with lessons, which teach about the successes of Blacks in STEM fields, that are hands-on, and that relate STEM to the students' everyday lives. These lessons often integrate more than one STEM subject and require the students to carry out an experiment or build something, which are aspects of authentic STEM education. To aid students in envisioning people of African descent in STEM fields, the ILA hires mentors, who are of African descent and are currently in university programs, to deliver the ILA curriculum to students in a non-formal after-school programme.

This study investigated students' perceptions of the ILA after-school programme and STEM, to learn whether the ILA had helped students to develop positive attitudes towards STEM subjects. The participants in this study revealed their personal meta-cognitive beliefs, which for those interviewed were that learning STEM successfully, depends on how it is presented, as well as, on the teacher/mentor who is presenting it. Students recognized that excelling in STEM was not an individual quest based entirely on one's effort, as meritocratic thought would suggest. With regards to how the ILA presented STEM content, all interviewees including those with negative perceptions of STEM and those with positive views of STEM, spoke candidly and had an appreciative attitude towards the "hands-on" approach to learning, found in many of the ILA activities. Students thought this pedagogical strategy helped them to understand STEM better. In spite of this, the majority of students in this study did not aspire to STEM careers as hoped. Additionally, when asked to draw a scientist, none of the ILA students drew a Black scientist, indicating that students are still thinking stereotypically. The ILA needs to emphasize the works of scientists of African descent, and mentors need to strengthen their bond with ILA participants. This will ensure that the participants see past and present members of the Black community who are making advances in STEM, so that African Nova Scotian learners involved in the ILA will begin to internalize that they too can excel in STEM. Until then, the ILA will continue to provide a space where students can: explore STEM in a way they desire, through a hands-on approach; learn a STEM curriculum that is culturally relevant; and learn with mentors who are leading the way in their own STEM pursuits. The ILA will continue to supplement the Nova Scotian curriculum, providing the necessary alternative discourses needed for redressing the issues Black learners face in Nova Scotia, so that these learners will view STEM as a possibility.

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6. Appendices

IMHOTEP'S LEGACY ACADEMY

Appendix A: About the ILA

Imhotep's Legacy Academy (ILA) is an effective and successful provincial, STEM outreach organization, established in 2003. Based at Dalhousie University, ILA is built on a strong university-community partnership. It aims to redress the under-representation of African Canadians in post-secondary STEM (science, technology, engineering, mathematics) studies.
ILA offers programming to students in junior high, high school, and university:

(1) The After School Program (ASP) component is structured to sustain contact with the learners over three years (grade 7, 8, 9) during a crucial phase in their academic careers. University science and engineering students, acting as mentors, foster positive social interactions with young learners, and deliver STEM-enrichment activities including on-site experiments and field trips. Mentors also provide curriculum tutoring in math and science. ILA has After School Programs established at Oxford Junior High School, Halifax; Caledonia Junior High School, Dartmouth; Truro Junior High School, Truro; St. Andrews Junior High School, Antigonish; and Memorial Junior High School, Sydney.

(2) The First Lego League (FLL) is a robotic competition that targets junior high students between the ages of 9-14. Each year, teams of young people design, build, and program robots using only Lego to perform specific tasks based on a specific theme. Teams have the opportunity to compete in regional and provincial competitions each year. Students gain unique experience by being exposed to mechanical engineering and computer programing concepts. They also learn how to solve specific problems in different ways. Since 2011, ILA has hosted FLL programs. Currently, ILA has FLL programs established at Oxford Junior High School, Halifax and Truro Junior High School, Truro. Over the years, ILA teams in both regions have received awards for "Presentation", "Mechanical Design", "Technical Design", and "Enthusiasm and Spirit" at the regional or provincial competitions.

(3) The Virtual School Program (VSP), launched in 2009, is tailored to provide free tutoring and supplemental education support in science and math to high school students. Furthermore, the VSP is designed to mitigate the geographic and economic constraints that hinder African Nova Scotian learners' access to science-learning opportunities. Mentors interact with participants virtually through an online classroom or in person at the ILA Office, after school hours.
Secondary students participating in any of ILA's after-school programs can earn an ILA-TD Opportunity Scholarship to study in STEM-related fields at Dalhousie University upon graduation from high school. This is a renewable scholarship valued at (up to) $5,000/yr.

(4) Summer Research Fellowships are open to African Canadians enrolled in an undergraduate degree in science, engineering, or health professions, at any post-secondary university in Nova Scotia. ILA has partnered with Dalhousie University's Faculty of Science, Faculty of Engineering, and Faculty of Health Professions to create scholarships, valued at $6,500 each, which are tenable at Dalhousie University and are paid-out over the summer months (May – August) to support university students as they conduct specialized research in their chosen field under the guidance of a Dalhousie faculty member whose primary appointment is in the Faculty of Science, the Faculty of Engineering, or the Faculty of Health Professions.
ILA has also partnered with the Faculty of Medicine to create Summer Research Studentships valued at $5,000. The Summer Student Research Program for Non-Medicine Students was created to increase the number of African Nova Scotians in medicine by providing medically-related research experience. Students will gain valuable experience in the design, execution, and evaluation of experiments.

Appendix B: Survey Instrument.

1. What is your name?

2. What is your age?

3. What is your gender?

4. Choose all of the Imhotep legacy Academy After-school Programmes you have taken and/or are currently taking.

	Did you attend? (drop down menu, yes/no)	If you attended, how often did you attend? (drop down menu, every week, every other week, less than every other week)
Grade 7		
Grade 8		
Grade 9		
First Lego League		

5. At what school do you attend the Imhotep's Legacy Academy after-school programme?

6. What grade are you in?

7. Going to the ILA after-school programme helped me enjoy STEM (Science, Technology, Engineering, and Mathematics).

Yes or no

8. Explain your answer to the above question.

11. Before starting the ILA after-school programme I enjoyed STEM.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

12. Students should learn about STEM in high school.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

13. The ILA after-school programme made me want to go to college or university to take a STEM course(s).

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

14. I do not think STEM is of great importance to a country's development.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

15. The hands-on activities offered by the ILA after-school programme helped me to enjoy STEM.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

16. I do not think STEM is useful for solving the problems of everyday life.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

17. Place a check mark to the right of any activities the ILA after-school programme made you want to engage in during your spare time.

	Yes	No
STEM TV programmes		
STEM Online programmes		
At home experiments		
STEM books		

	Yes	No
Other STEM activities		

18. Before going to the ILA after-school programme I did not want to have a job in a STEM field.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

19. I would like to go to college or university to take non STEM course(s).

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

20. I think STEM is of great importance to a country's development.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

21. Before going to the ILA after-school programme I did not think I was able to work toward a job in a STEM field.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

22. I think STEM is useful for solving the problems of everyday life.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

23. I would not like to go to college or university.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

24. Before going to the ILA after-school programme I wanted to have a job in a STEM field.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

25. The ILA after-school programme did not make me to want to take a STEM course(s) in high school.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

26. The ILA after-school programme made me think STEM is important in most of today's jobs.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

27. I do not think I can do well in STEM courses.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

28. After going to the ILA after-school programme I wanted to have a job in a STEM field.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

29. Students should not learn about STEM in high school.

Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree

30. The ILA after-school programme helped me to think STEM is of great importance to a country's development

Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree

31. There is a great need for STEM in most of today's jobs.

Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree

32. I would like to go to college or university to take STEM course(s).

Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree

33. Before going to the ILA after-school programme I thought I could do well in STEM courses.

Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree

34. Before going to the ILA after-school programme I did not enjoy STEM

Strongly Disagree | Disagree | Neither Disagree Nor Agree | Agree | Strongly Agree

35. The ILA after-school programme made me think that STEM is useful for solving the problems of everyday life.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

36. Before going to the ILA after-school programme I thought I would be able to work toward a job in a STEM field.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

37. After attending the ILA after-school programme I thought I could do well in STEM courses.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

38. The ILA after-school programme has made me to want to take more than the needed amount of STEM course(s) in high school.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

39. There is little need for STEM in most of today's jobs

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

40. After attending the ILA after-school programme I believed I could work toward a job in a STEM field.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

41. Before going to the ILA after-school programme I did not think I could do well in STEM courses.

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree

42. The ILA after-school programme influenced me to think students should learn about STEM in high school.

Appendix C: Survey Score Sheet.

Question	Type of question or	Weight or Scoring (SD = strongly disagree and SA = Strongly Agree)
1-6	Demographic	N/A
7	Perceptions of STEM	1-5 SD-SA
8	Perceptions of STEM	N/A
11	Perceptions of STEM	N/A
12	Academic Choices	1-5 SD-SA
13	Academic Choices	1-5 SD-SA
14	Perceptions of STEM	5-1 SD-SA
15	Perceptions of STEM	1-5 SD-SA
16	Perceptions of STEM	5-1 SD-SA
17	Perceptions of STEM	N/A
18	Career Choices	N/A
19	Academic Choices	n/a
20	Perceptions of STEM	1-5 SD-SA
21	Career Choices	N/A
22	Perceptions of STEM	1-5
23	Academic Choices	5-1 SD-SA
24	Career Choices	N/A

25	Academic Choices	5-1 SD-SA
26	Career Choices	1-5 SD-SA
27	Academic Choices	5-1 SD-SA
28	Career Choices	1-5 SD-SA
29	Academic Choices	5-1 SD-SA
30	Perceptions of STEM	1-5 SD-SA
31	Career Choices	1-5 SD-SA
32	Academic Choices	1-5 SD-SA
33	Academic Choices	N/A
34	Perceptions of STEM	N/A
35	Perceptions of STEM	1-5 SD-SA
36	Career Choices	N/A
37	Academic Choices	1-5 SD-SA
38	Academic Choices	1-5 SD-SA
39	Career Choices	5-1 SD-SA
40	Career Choices	1-5 SD-SA
41	Academic Choices	N/A
42	Academic Choices	1-5 SD-SA

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Appendix D: Consent Form

Project Title: Informal STEM (Science, Technology, Engineering, and Mathematics) Education: Students' Perceptions of The Imhotep's Legacy Academy After-school Programme.

Research Supervisor: Dr. Anthony Bartley, Professor at Lakehead University, (807) 343-8896, abartley@lakeheadu.ca

Student researcher: Diandra Singh, Graduate Student Lakehead University, (647) 244-9963, dsingh1@lakeheadu.ca

Dear Parent/Guardian,

Your child is invited to take part in a study being conducted as masters' thesis research by Diandra Singh who is a graduate student in the education programme at Lakehead University. Taking part in the research is completely up to you and your child; it is entirely your choice. Even if your child takes part he or she can leave the study at any time for any reason. The information below tells you what is involved in the research, what your child will be asked to do and any benefits, inconveniences or discomforts that your child might experience.

Your child will be free to ask as many questions as he/she likes and if you have any questions please feel free to contact Diandra Singh or Anthony Bartley.

Purpose and outline of the research study:

An evaluation of the Imhotep's Legacy Academy (ILA) will be done in the winter (February) with the goal of helping improve the programme. The study is aimed to learn what students think about the programme and how the programme might have shaped their views on science, technology, engineering, and mathematics. Students that are in the ILA will be asked to answer a survey and then 4 students who answered the survey will be asked to take part in short interviews with the researcher, Diandra Singh. The survey should take about 20 minutes to be completed and the interview, which will happen on another day will only take about 30 minutes.

Who can take part in the research study?

Anyone who is in the Imhotep's Legacy Academy After-school Programme can be a part of this study. As a student in the Imhotep's Legacy Academy After-school Programme your child is invited to take part in this study because this study is seeking the views of current ILA participants.

How many people are taking part in the study?

It is hoped that most of the current ILA participants will take part, which would be around 50 students.

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What your child would be asked to do?

This research would ask that your child complete an online survey about the ILA. The survey will be completely anonymous to the public and neither teachers nor ILA staff will have access to the survey results. Only the researcher will know your child's responses to the survey questions. Diandra Singh, will be giving the students the surveys and she will make sure all responses are kept confidential. After looking at the results of the surveys, Diandra will select 4 participants who had different survey results to have separate interviews, to gain a better understanding of their perspectives. Your child may not get chosen for an interview because only 4 participants will be selected. The interview will consist of Diandra asking your child questions about their thoughts on the ILA. The interview will be audio recorded and the entire recorded conversation will be written up by Diandra. Both the survey results and interview records will be securely stored by the researcher for 5 years and after that point she will destroy them. Participants for both the survey and interview will be ensured that they do not have to answer any questions they do not want to. Interview participants can stop the interview whenever they wish. Interview participants' identities will be kept anonymous and an alias will be given to them when the research findings are reported.

Possible benefits, risks, and discomforts

If your child will continue to be a part of the Imhotep's Legacy Academy After School Programme it is possible that the results from this study, may cause the programme to improve certain aspects, which your child may get to experience. However, as it is not clear what students will say in the study, or how long it might take for improvements to be made to the programme, your child may not get to experience those benefits.

There will not be any physical risks to your child, as the nature of this research does not require your child to be active. Due to the fact that both the survey and interviews will require your child to reflect on their experiences with the After-school programme and with science, technology, engineering, and mathematics there is a chance that your child may face psychological discomfort if he/she has had very negative experiences. To minimize these risks I will ensure that participants are comfortable before they start the survey or interview. I will reassure participants to ask many questions and I will remind them several times that they do not have to answer any questions that make them uncomfortable. If necessary your child can leave the interview where support staff can speak to him or her.

What will your child receive for taking part?

Your child will not receive anything for taking part in the study.

How your child's information will be protected:

All the data from the study will be password protected on Diandra's computer. She will be the only person that will have access to it. Both the survey results and interview records will be securely stored by the researcher for 5 years and after that point she will destroy them. The only limits to confidentiality would be if a child reports abuse. In this case, due to legal obligations Diandra will have to report to authorities. However, that is a highly unlikely issue with this study as the questions are all about science. Participants' identities will be kept anonymous in all reports. In Diandra's thesis code names will be used, as well as in the newsletter to the ILA community (parents, mentors, board of directors, and students) and the formal report for the ILA. This means your child will not be identified in any reports.

If your child decides to stop participating:

Your child is free to leave the study at any time. If he/she decides to stop participating at any point during the study, he/she can also decide whether he/she wants any information that was contributed up to that point to be removed or if he/she will allow Diandra to use that information. Stopping participation will not affect your child's relationship with the ILA.

How to obtain results:

The results from this study will be made available through a newsletter for the ILA community, through a formal report for the ILA board of directors, and through a master's thesis. The newsletter will be given to your child before the end of the school year at one of their ILA After-school programme meetings. The newsletter will include contact information for where the other reports can be accessed online.

Questions

Diandra and Dr. Bartley are happy to talk with you or your child about any questions or concerns you may have about your child's participation in this research study. Please contact Diandra at (647) 244-9963 or at dsingh1@lakeheadu.ca or contact Dr. Bartley at (807) 343-8896 or at abartley@lakeheadu.ca Due to the fact that Diandra and Dr. Bartley may be in Ontario, if you leave your contact information with your child's ILA mentor they will let Diandra know and she will follow up through phone call.

This study has been approved by the **Lakehead University Research Ethics Board**. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team please contact Rebecca Scott, the Research Coordinator at 807-343-8933 or research@lakeheadu.ca.

Informal STEM Education: Students' Perceptions of The Imhotep's Legacy Academy After-school Programme.

Parental Consent Form

Research Supervisor: Dr. Anthony Bartley (807) 343-8896 abartley@lakeheadu.ca
Student researcher: Diandra Singh (647) 244-9963 dsingh1@lakeheadu.ca

I (print name)____ the parent/guardian of ____ have read the explanation about this study and have been given the opportunity to discuss any questions I had. To ensure the terms of the study are understood please check yes or no to the following statements.

I read and understood the information letter for the study, including the risks and benefits.	Yes	No
I also understand that my child is a volunteer and can withdraw from the study at any time, or choose not to answer any question.	Yes	No
I understand that all surveys and interview data will be securely stored at Lakehead University for a period of 5 years.	Yes	No
I understand that results from the research will be available through a newsletter towards the end of the school year.	Yes	No
I understand that my child's identity will remain completely anonymous in any publication or public presentation of this research	Yes	No
By placing a checkmark in the yes box I agree that my child may take part in both the survey and interview section of this study.	Yes	No
By placing a checkmark in the yes box I agree that the researcher may audio-record the interview with my child.	Yes	No
By placing a checkmark in the yes box I agree that my child may take part in the survey.	Yes	No

Signature of Parent/Guardian ____________________________ Date _________________________

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Informal STEM Education: Students' Perceptions of The Imhotep's Legacy Academy After-school Programme.

Student Consent Form

Research Supervisor: Dr. Anthony Bartley (807) 343-8896 abartley@lakeheadu.ca
Student researcher: Diandra Singh (647) 244-9963 dsingh1@lakeheadu.ca

I (print student's name)____, as a participant in the ILA, have read the explanation about this study and have been given the opportunity to discuss any questions I had. To ensure the terms of the study are understood please check yes or no to the following statements.

I read and understood the information letter for the study, including the risks and benefits.	Yes	No
I also understand that I am a volunteer and can withdraw from the study at any time, or choose not to answer any question.	Yes	No
I understand that all surveys and interview data will be securely stored at Lakehead University for a period of 5 years.	Yes	No
I understand that results from the research will be available through a newsletter towards the end of the school year.	Yes	No
I understand that my identity will remain completely anonymous in any publication or public presentation of this research.	Yes	No
By placing a checkmark in the yes box I agree to take part in both the survey and interview section of this study.	Yes	No
By placing a checkmark in the yes box I agree that the researcher may audio-record my interview.	Yes	No
By placing a checkmark in the yes box I agree to take part in the survey.	Yes	No

Signature of student ___________________________ Date ________________________