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Exploring young children's science identity authoring in a STEAM-enriched community-based programme

Roots: Ik ben Science!

PhD thesis

to obtain the degree of PhD at the University of Groningen on the authority of the Rector Magnificus Prof. J.M.A. Scherpen and in accordance with the decision by the College of Deans.

This thesis will be defended in public on Monday 25 September 2023 at 16:15 hours

by

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I dedicate this thesis to all the families, volunteers, and staff at the Trefpunt, who all supported Roots. To the families who participated in Roots, thank you for affording me the honour of telling your stories. I literally could not have accomplished this without you. I hope you, too, have benefitted from the experience as much as or more than I have. I wish you all of life’s successes and happiness. May our paths cross again in the future.

To my biggest and loudest cheerleaders: my beloved sister and BFF, Tameka Baker, and my nieces, Amy, and Leah Baker. Tammie, Amyster and Lee lee, for all the times we did science experiments in the backyard, you were my first participants before Roots was even a seed of thought.

To Lucy, Mónica, and Jenn we set out on a path unknown and left a trail.
Contents

Chapter 1: Introduction ................................................................................................................... 7
Importance of Informal Science Education .................................................................................... 8
Science Identity, Figured World, and Identity Resources ............................................................. 9
Research Design and Context of Study ........................................................................................ 10
  Context........................................................................................................................................... 11
    Situating race and ethnicity, whiteness, and immigration ........................................................... 12
  Overview of Dutch Education ........................................................................................................ 14
Planning and Design of Roots: “Ik ben Science!” ......................................................................... 14
  Gaining access in the research context ........................................................................................ 14
    Recruitment of families ............................................................................................................... 15
STEAM-enriched Culturally-adapted Curriculum.......................................................................... 16
Structure of the thesis .................................................................................................................... 18
Significance ................................................................................................................................... 19
Chapter 2: An AfroCaribbean Science Teacher’s Quest for Healing .............................................. 20
A Wellness Project .......................................................................................................................... 20
Abstract .......................................................................................................................................... 21
An AfroCaribbean science teacher’s quest for healing: A wellness project .................................... 22
  Identity, Emotions and Wellness ................................................................................................... 23
Methodology .................................................................................................................................... 25
  Multi-methodological Inquiry ....................................................................................................... 26
    The Events That Led to Inquiry .................................................................................................. 28
    Resetting the Path to Wellness ................................................................................................. 37
  Notes ............................................................................................................................................. 38
Chapter 3: Culturally relevant/responsive and sustaining pedagogies in science education: Theoretical perspectives and curriculum implications .................................................. 39
Abstract.......................................................................................................................................... 40
Culturally relevant/responsive and sustaining pedagogies in science education: Theoretical perspectives and curriculum implications ........................................................... 41
  The urgency of centering non-dominant voices in science education ....................................... 42
  Purpose....................................................................................................................................... 43
  The hegemony of science and science education ................................................................. 43
  Dutch background and context ............................................................................................... 46
An overview of the Dutch schooling context ............................................................................. 49
  Critical theory ............................................................................................................................. 52
    Culturally responsive education: to whose culture are we responding? ............................ 53
Disrupting the images of who is a scientist ................................................................. 178
Return to Affordances, Hybrid Spaces and Science Identity Authoring .................. 180
Implications and opportunities .................................................................................. 183
Main Findings ............................................................................................................ 188
Contributions .............................................................................................................. 191
Implications for theory ............................................................................................... 195
Implications for methodology and research ............................................................. 196
Methodological implications ....................................................................................... 196
Research implications ................................................................................................. 197
Implications for practice and policy .......................................................................... 198
Practical implications .................................................................................................. 198
Policy implications ...................................................................................................... 199
Limitations and methodological reflections ............................................................... 201
Final Note ..................................................................................................................... 204
References ................................................................................................................... 206
Appendices ................................................................................................................... 236
Appendix A .................................................................................................................... 236
Appendix B .................................................................................................................... 240
Appendix C .................................................................................................................... 242
Appendix D .................................................................................................................... 243
Sample of possible interview questions discussed prior to commencement of second phase study. 243
Appendix E .................................................................................................................... 244
Appendix F .................................................................................................................... 247
Needs assessment ........................................................................................................ 247
Appendix G .................................................................................................................... 248
Alternative To In-Person Meetings (in case of lockdown) (October - December) ....... 249
Appendix H .................................................................................................................... 251
Example of lesson plan ............................................................................................... 251
Appendix I .................................................................................................................... 253
Summary ...................................................................................................................... 253
Samenvatting in het Nederlands .................................................................................. 267
Acknowledgements ..................................................................................................... 271
Contributions .............................................................................................................. 277
Curriculum Vitae ......................................................................................................... 279
Chapter 1: Introduction

The right to pursue science is an inalienable right of every individual in international law, according to article 27 of the 1948 Universal Human Rights Declaration and article 15 of the 1976 United Nations International Covenant on Economic, Social and Cultural Rights (O’Neil, 2018). However, half a century after this treaty, concerns for equal and full participation of some groups persist, especially for women, girls, and non-dominant ethnic, racial and religious groups who have been historically minoritised in science education (Archer & Levitt, 2016; Avraamidou, 2020; Brickhouse, 2000; Visintainer, 2020). For example, according to an OECD (2018) report on Bridging the Digital Gender Divide, women and girls still do not have equal access to educational and professional attainment in digital arenas such as science, technology, engineering, mathematics (STEM). These gaps in science achievement also affect other vulnerable groups and confine the social progress of children in education (OECD, 2018), science education notwithstanding.

Furthermore, barriers that limit diverse populations’ interest, engagement, and achievements in science, as well as their access to it, set the stage for stifling the inclusion of innovative and creative ideas in combatting societal challenges. For instance, according to the 2018 World Economic Forum Gender Gap Report, women still do not have full access to and equal participation in science even though their engagement in science would be beneficial to increase the impact of science in society (World Economic Forum Gender Gap Report, 2018).

However, some efforts are being made towards mitigating these trends in inequities in science participation as some countries commit to national initiatives to encourage a more scientific society, which includes improving diversity and inclusion in science participation. This commitment is seen in the Netherlands’ National Science Agenda to a Vision for Science 2025 (Ministry of Education, Culture and Science, 2014).

The vision document outlines the Dutch government and scientific institutions' intention “to strengthen the position of Dutch science, which entails making greater use of the region as the locus of interaction and cooperation between science, government authorities, private sector organisations and the societal field” (p. 96). The vision document emphasises that science should be visible and accessible to all ages and not be limited to only scientists. The document also underscores that maximum visibility can be achieved through informal science education (ISE), for example, the media, social media, television programmes, science museums, public debates, exhibitions, e-learning (e.g., the ‘massive online open
courses’, or MOOCs) and the ‘science shops’ (Vision for Science 2025, Ministry of Education, Culture and Science, 2014, p. 46).

One approach to informal science education (ISE) provides a bridge between the school and home and facilitates young children’s participation in science (Wade-Jaimés, 2021). It affords children equitable access to engaging in science practices, making sense of the content, and applying it to their lives. Thereby, children are not just consumers of knowledge but become constructors of knowledge. Informal science learning has improved students’ interests and abilities in science learning (Bell et al., 2009; Calabrese Barton et al., 2013; Lin & Schunn, 2016). It is instrumental in helping children make the connection between everyday experiences, out-of-school science engagement, and in-classroom science learning experiences.

It is at this juncture of integration between the university and the community that this thesis offers a contribution to increasing children and their families’ participation in science and anchoring the role of science in their everyday lives. This thesis is focused on science engagement through a community-based approach to ISE.

**Importance of informal science education**

ISE, also known as out-of-school learning, entails how individuals learn about and engage with science throughout their lifespan outside of the formal education system (Falk & Dierking, 2018). Informal science learning can occur outside the school building and the formal educational setting, can be used as a bridge between the formal and informal curricula or can be infused within the formal curriculum as an enrichment program (Lin & Schunn, 2016). It is fluid: settings and practises fall on a formal and informal science learning continuum.

Generally, ISE focuses on the institutions and school partnerships that provide complementary science-based reinforcement to the formal school curriculum: museums, zoos, aquaria, science centres and botanical gardens are considered ideal environments for informal learning (Adams & Gupta, 2017; Dawson, 2014). In fact, science centres and museums are dubbed as a resource to broaden participation and increase access to science (O’Neil, 2018). For instance, the significance of informal science institutions being recognised as a vehicle to connect people with science is evident in the organisation of UNESCO’s World Science Day for Peace and Development and International Science Center and Science Museum Day on November 10 (O’Neil, 2018; UNESCO, 2022).

In as much as ISE institutions such as museums and science centres are categorised as
resources, concerns of equity and access are present in these informal learning environment spaces, as some marginalised groups of the population still do not feel that they belong in these settings (Dawson, 2014). In a review study on participation, equity and social inclusion and exclusion in ISE, Dawson (2014) used a three-part access framework – infrastructure access, literacy, and community acceptance – adopted from community computer literacy studies to examine access and equity in ISE.

Dawson (2014) reported that participation and non-participation is oftentimes driven by who has social advantage to do so and ISE is not fully public in respect to accessibility, inclusion, and equity. This thesis responds to Dawson’s (2014) query of how ISE can be more accessible by using a community-based approach, in which the ISE researchers meet the children and families where they are and science is brought to their neighbourhood, instead of them visiting institutionally organised spaces such as museums and science centres.

A community-based model fosters mutual learning and sharing of knowledge among all the stakeholders through collaboration, co-production, and co-creation (CSCCE, 2020). The stakeholders in the research project that is the focus of this thesis are the children and their families, facilitators, volunteers, scientists, and researchers. Furthermore, learning and participating in science activities that benefit their community has the potential to support children as lifelong science learners and participants (Roth & Lee, 2004).

Regardless of how it is defined and the structure of the environment in which learning occurs, ISE science-rich spaces for children and their families helps them “pursue and develop science interests, engage in science inquiry, and reflect on their experiences through sense-making conversations” (Bell et al., 2009, p. 2) giving them autonomy over their science learning and engagement. Moreover, affording children this self-directed approach to engaging in and building their science interests and knowledge positions them as agents in authoring a science identity.

Science identity, figured world, and identity resources

Science Identity is the theoretical construct used to examine children’s learning and participation in science in this thesis. The construct of science identity is broadly defined as the perception of oneself as well as the recognition by others as a science person (Carlone & Johnson, 2007). Science identity is “multidimensional, multifaceted, and complex” (Varelas, 2012, p. 14). Identity is continuously being reconstructed across time and space (Carlone & Johnson, 2007), in addition to being reshaped as learning is enacted in formal and informal

In this thesis, the social interactions are embedded in the participatory community-based context, reinforcing the children’s science identities as they are under constant construction and co-construction. These salient moments of social and cultural interactions and enactment form the basis for the embodiment and development of identity.

We use Figured Worlds and Identity Resources as a combined analytical framework to illustrate how children author their science identities in various worlds, or what we refer to as spaces, in this thesis. The premise is that science is a figured world where members are recruited into, where they enact practices and become embodied in their roles (Holland et al., 1998). Figured worlds are sociocultural in construction and imagination; they require the interaction of people who assign meaning to the artefacts to direct practices (Holland et al., 1998). In these imagined worlds, people and artefacts take on a new meaning that exists within one frame in the world but is not fixed to that frame. The frames are fluid and are constantly in flux, similarly to how one’s identity is under negotiation. Thus, participants create and recreate meaning during interactions with each other in the worlds they are figured into (Urietta, 2007).

In this thesis, the notion of Figured Worlds is suitable as a theoretical and analytical tool because it provides a critical lens to examine children’s identity construction, agency, social interactions and cultural positionings. Identity Resources are also used as an analytical tool. These resources are expressed as material, relational and ideational. Material resources are the physical artefacts in the context; relational resources are interpersonal connections to others in the context and outside the context; ideational resources are ideas about how one sees themselves and their relationship to a place and the world (Nasir & Cook, 2012). For the purpose of this thesis, the Identity Resources framework was applied to explore the kinds of resources that children are afforded and enact as they form and negotiate their science identities.

**Research design and context of study**

The focus of this thesis as an ISE research project is informed by culturally relevant-sustaining pedagogies (CR-SP), community-based STEAM-enriched programme called Roots:Ik ben Science! (pseudonym Community Roots). The project centred asset-based pedagogy, such as culturally relevant/responsive and sustaining pedagogies (CR-SP), in the curricular design. CR-SP is coined by blending the culturally-rich and critical pedagogies of *culturally relevant pedagogy* (Ladson-Billings, 1995), *culturally responsive pedagogy* (Gay,
and culturally sustaining pedagogy (Paris, 2012). Centring the project around CR-SP afforded a space to co-create and co-construct knowledge where children are agentic in deciding the science engagement of what they can and want to do.

Broadly, adopting the perspectives and constructs of science identity in examining children’s learning and participation in science, the initial questions that guided the design of the study, which includes the design of the curriculum, curation of the space, enactment of the curriculum, and the data collection include the following: How are children positioned within the culture of science? How do they position themselves in science? How do they form, negotiate, and author their science identities? How are children's science identities shaped through their engagement in a CR-SP-informed, community-based STEAM program? How do the different types of identity resources support children’s science identity authoring?

**Context**

The context is defined by a community-based science program, as a place where facilitators, researchers, family members, the curriculum, and children interact and constantly inform each other. The neighbourhood is located in the east of the municipality of Groningen, in the northern province in the Netherlands. Located in the eastern section of the city, the neighbourhood was once a farming community but has grown to 13000 residents within an urban city with a population of 202,810 (www.cbs.nl). It is considered one of the most multicultural neighbourhoods in the municipality, which made it the most likely choice to conduct the study, since we wanted to have a diverse population of families and children.

Given that the purpose of the study was to explore children’s participation in science, those from marginalised groups notwithstanding, therefore, a neighbourhood that would most likely put us in direct contact with families from diverse ethnic, immigration, and economic backgrounds was more optimal for the context of this thesis.

Beyond the local context, in the design of the study takes into account the historical context of the Netherlands, and therefore becomes a salient part of this thesis. A broad focus of the study is on Caribbean families and thus we look at the colonial history of the country and how Caribbean identity is positioned within the Dutch cultural identity in establish arguments around centring Caribbean cultural identity in the study’s design and in the arguments for using culturally adaptive pedagogies in the curricular design. Pursuing an interdisciplinary approach to education allows us to draw on the socio-political and historical contexts which in turn widens the range of qualitative topics to study (Westberg, 2023), the
In framing this socio-political and historical of this thesis, we use a colonised rather than racialised identities since using colonised allows us to highlight how the discourse on race is treated in the Netherlands or Western Europe. Using a colonised framing also generates themes on race and ethnicity, whiteness, and immigration. In the next sections, we expand on how these constructs are situated within the European context.

**Situating race and ethnicity, whiteness, and immigration**

Renowned race theorists in the Netherlands, Philomena Essed (1991) argues that a, where the story of the “Black Diaspora in Europe… is one of colonialism, not slavery” (p. 14) Unlike in the United States, in Europe, the colonial outposts were in operation outside of the empires. Therefore, the Dutch citizenry did not have close encounters with their colonial Dutch counterparts, who subsequently became the Other. This limit contact remained until the rise in immigration from the colonies post-World War II recruited to rebuild western Europe, including the Netherlands (Essed, 1991).

To interpret the presence and portrayal of race and racism in Europe is to have what Bonilla-Silva (2015) calls for an “analytical crux for understanding racism is uncovering the mechanisms and practices (behaviours, styles, cultural affectations, traditions, and organizational procedures) at the social, economic, ideological, and political levels responsible for the reproduction of racial domination” (Bonilla-Silva, 2015, p. 75).

Understanding race as a construct within the European context, similarly to the North American context, one has to understand the centrality of racism within society and in particular through a colonial lens. The United Kingdom-based critical race theorist, David Gillborn (2006) asserts that “it is of central importance that the term “racism” is used not only in relation to crude, obvious acts of race hatred but also in relation to the more subtle and hidden operations of power that have the effect of disadvantaging one or more minority ethnic groups” (Gillborn, p. 21). Gillborn’s (2006) argument mirrors that of Bonilla-Silva (2015) in imploring researchers to take into account the all-encompassing way that race and racism operates within society. It is manifested in various ways within institutions and as such is systemic in operation.

In discussing race, there is another term that comes into play, that is ethnicity. Ethnicity, as the renowned cultural studies figure, Stuart Hall (2017) opines ‘ethnicity’ is subsumed under race and takes into account “shared languages, traditions, religious beliefs, cultural ideas, customs, and rituals that bind together particular groups” (p. 83). In this thesis,
ethnicity is not dealt with separately from race. However, what is emphasised is identity of being Black, Caribbean, in particular. Instead, we seek to unpack colonial ties as it relates to the Caribbean Diaspora in the chapters; as a result, what is most distinguished is the juxtaposition of Caribbean-ness to that of whiteness.

Whiteness in Europe is considered the norm and is felt in the global reach of the colonial projects. Within the purview of what is constituted as the norm has perpetuated “racism as an operational norm resulting in exclusion, …, isolation and limited degrees of citizenship for individuals who are not racialised as White” (Essed et al., 2018, p. VI). Sara Ahmed (2007) articulates that whiteness is racialisation and is cultivated in doing. The acts of doing symbolise objectification and domination; whiteness is "'real', material and lived" (Ahmed, 2007, p. 150).

The Caribbean diaspora is not singularly one race or ethnic group but an amalgamation of many. And as Stuart Hall (1999/2019) discusses, our intertwining history is the essence of what makes up our hybrid identities — a hybridity that creates a sort of creolising of tongue and race. Here Stuart Hall (1999/2019) explains:

In the Caribbean, ‘Africa’ has since been joined by the East Indians and the Chinese: indenture enters alongside slavery. The distinctiveness of our culture is manifestly the outcome of the most complex interweaving and fusion in the furnace of colonial society of different African, Asian, and European cultural elements. This hybrid outcome can no longer be easily disaggregated into its original ‘Authentic’ elements. (p. 211)

Thus, race and ethnicity are treated as one concept and what is critical is identity is context specific. For example, an AfroCaribbean woman in the United States might find that her Blackness is more salient in most places, and her Caribbean-ness takes a backstage to her racial identity. Whereas the foremost identity marker for a young Caribbean girl in the Netherlands is her Caribbean-ness.

In light of the socio-historical context of Netherlands and its Dutch Caribbean citizens, we developed an interdisciplinary research study design that considered the historical and sociocultural conceptualisation of ISE.

Consequently, in further situating the context of the thesis, and layering the context-bound experiences children may have in science, especially those from Caribbean backgrounds, we outline the tracking system of schools in the Netherlands to understand the educational infrastructure in the following section.
Overview of Dutch education

The Dutch education system is overseen by the Ministry of Education, Science and Culture. Children enter bassischolen (primary school) at age four or five in group one. At the age of 12, they will take the Centrale Eindtoets Basisonderwijs, which is also known as CITO test at the end of group 8. This means the child enters high school in grade seven, at 12-plus years old (‘t Gilde & Volman, 2021). Then, based on the CITO test scores and teacher recommendations, the child moves on to one of the three tracks for high school. The Dutch educational system is tracked into three pathways: MBO, HAVO and VWO. Within the VWO track there is also the athenaeum, gymnasium, or lyceum; these are “specialised high schools that offer Latin and ancient Greek” (‘t Gilde & Volman, 2021, p. 139).

The three tracks result in a different educational level: an MBO certificate leads to a vocational certificate, whereas the pre-university tracks of HAVO and VWO lead to either a vocational university degree at HBO or University of Applied Sciences, or a WO at a research university institution. Though this study takes place in an informal science setting, a brief summary of the Dutch education system will give a glimpse into children’s grades in primary school, which is featured in chapters two and four. The coming sections describe the design of the research project, Roots: Ik ben Science! followed by an overview of the thesis and a synopsis of the subsequent chapters.

Planning and design of Roots: “Ik ben Science!”

Gaining access in the research context

To gain access to families and children and advertise the programme, we employed the purposeful sampling technique of snowballing (Merriam & Tisdell, 2016). Purposeful sampling is a non-probabilistic approach to sampling that allows the researcher to gain in-depth information about the cases they want to study. The snowball method is a type of method where a few participants are identified based on the criteria of the sample and then those participants will refer to other participants (Merriam & Tisdell, 2016). This type of sampling allowed the researchers who are new to the context to have a greater reach when inviting families to the programme. In addition to the families referring others to the programme, the researchers worked with a community liaison to also invite families in their network.

To consider the affordances and constraints of the study, we conducted 30–60-minute interviews with five families to get a needs assessment to determine whether such a
programme was warranted. Children from four of those five families joined the programme. The questions they were asked to respond to were: Is such a study warranted, to begin with? Will this program be beneficial to families? What are families' perceptions of science? Is the project design aligned with the concept of what families think an after-school programme should be? Does the project encroach on the children’s and families’ time?

**Recruitment of families**

There were 25 families enrolled with children ranging from 6 to 12 years old. They were recruited through different avenues, which included four primary schools in the neighbourhood, a long-time community member, an online newspaper, a parent group, the community centre’s Facebook group and word of mouth. The author emailed the directors of four primary schools in the neighbourhood and then attended the schools to distribute flyers informing families about the programme. Some of the families that participated in the programme had responded to these fliers.

Initially, the author had been corresponding with one of the school directors the summer prior, requesting to work with the school directly. However, the school did not have the capacity to collaborate with another university project at the time. Additionally, the community centre posted a flyer with information about the event, including the dates that we would be in session. This information was also posted on their Facebook page. A notice was also sent to the online neighbourhood newspaper and shared in a mommy’s group for families. Some families were directly contacted through a community member who was well affiliated and known among the Dutch Caribbean community. Once in the programme, some children invited their friends to join.

The profiles of families who attended cut across the socioeconomic ladder, migrant and cultural backgrounds. The first five weeks of the programme took place between February and March 2020, then we had to postpone it until September due to the measures taken by the Dutch government to curb the spread of the COVID-19 virus. Every Saturday morning when we gathered at the centre, there were 35 people, including volunteers and families. The interdisciplinary group included facilitators, mostly volunteers, who were a diverse group of undergraduate, graduate and scientists from the alpha and beta sciences: physics, geosciences, science communication, physiology, pharmacology, and psychology.
STEAM-enriched culturally-adapted curriculum

The target lessons in the curriculum ranged from being nature- and arts-based to physics and engineering. For example, some of the lessons were dedicated to: Nature walk “Scavenging for Edible Plants”, Beekeeping, Earthquakes in the Area, Dancing, Improv, Art, Science projects and Meet-a-Scientist mini-lesson (brief chat with a scientist about their work and life). The following table gives an overview of the curriculum.

Table 1

An overview of the curriculum for the programme

<table>
<thead>
<tr>
<th>Theme</th>
<th>Learning Goals</th>
<th>Activities</th>
<th>CR-SP tenets/design dimensions</th>
<th>CR-SP including the topics that are relevant to the children’s lives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics and engineering</td>
<td>Students will engage in activities around renewable energy and engineering concepts. Each activity is a design investigation where they will explore how they can change variables in the mini-project to see how they impact their measurable variable, including robotics and building a microphone with material physicists.</td>
<td>In the north of the Netherlands, the children might see different forms of renewable energy being used. For example, we construct and compare the speed of the hovercrafts on different surfaces. The students will explore the force of friction caused by different surfaces. The following week we design and build wind turbines, which is followed by using solar power to power their insects made from renewable materials.</td>
<td>CR-SP including the topics that are relevant to the children’s lives.</td>
<td></td>
</tr>
<tr>
<td>Arts and Science</td>
<td>Through the incorporation of the arts, the students will explore different environmental themes using theatrical improvisation and dancing. We also use</td>
<td>The activities incorporate performing and visual arts.</td>
<td>CR-SP fosters a sense of belonging that includes not only the content but a transdisciplinary approach to the sciences that incorporate the</td>
<td></td>
</tr>
<tr>
<td>The Environment</td>
<td>Six-part lessons centred around the earthquakes happening in the north of the Netherlands as a result of gas extraction. Why is it happening? Who is benefitting from this venture? What are the social and environmental implications of such acts? Can it be prevented? What actions do we need to take to alleviate the situation?</td>
<td>Activities about earthquakes (e.g., the role of plate boundaries, seismic waves, measurements). All about earthquakes in Groningen and in the home countries of the parent generations; Social and Environmental Impact Awareness Building Sessions. Creating Public Service Announcements around the issue.</td>
<td>Recognising the political and environmental impact of the earthquakes happening in their province is crucial to their experiences. CR-SP as a practice encourages the inclusion of critical awareness of what is happening in the children’s environment.</td>
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<td>-----------------</td>
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<td></td>
</tr>
<tr>
<td>Personal Design Investigations</td>
<td>Children develop their own investigations. From these investigations, they will create presentations on their results for families and for the science festival, which attracts schools and children in the north of the Netherlands.</td>
<td>Create a space for the co-construction and co-creation of the issues students want to investigate in their neighbourhood. These are contextual and relevant to their lives, and they are the ones who would know what and how they want to address these issues.</td>
<td>CR-SP emphasises the need to have students tap into their creativity and resources to innovate ways of addressing issues that they encounter in their immediate and regional contexts.</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* This tabulated summary of the curriculum is adapted from chapter two (see Smith et al., 2022).
Structure of the thesis

The thesis is divided into six chapters including the introduction, general discussion, and conclusion. Each chapter is part of a whole that weaves together to provide a comprehensive overview of the rationale and the findings of the project.

In chapter two, as the autoethnographer, I present a description of my experiences as an AfroCaribbean science teacher in a public school in New York City. Through event-oriented and narrative inquiry guided by hermeneutic phenomenology, I explore the myriad of emotions I experienced as a racialised "other" in a majority White environment. Emotions are a prominent theme in these narratives, along with their role in my identity authoring. The implications of chapter three lie in its poignant storytelling of the Caribbean diasporic experiences and identity-making of a science teacher in the United States.

Most importantly, in chapter three we call for a critical look at the Netherlands, the context of the study, with a focus on the Dutch Caribbean community, which includes Suriname, the former Dutch Antilles, and Aruba. The chapter after the introduction offers a synopsis of the programme and argues for the use of asset-based pedagogies with Roots as an exemplar of a culturally relevant/responsive-sustaining pedagogies (CR-SP) centred community-based STEAM-enriched program for young children and their parents in the Netherlands. This chapter's major contribution was to provide a case for asset-based, culturally relevant/responsive, and sustainable pedagogies in scientific teaching and learning, particularly in former colonial settings.

Chapter four details the storied events of the diasporic experiences offered from another perspective: that of a young girl in the program. The thread that tethers these two chapters together is the nuanced experiences of the Caribbean diaspora.

In chapter four, we explore the relationship between the macrostructures of Caribbean diasporic identity and meso-structures of a Saturday Science community-based programme informing a Caribbean Dutch girl's science identity authoring. Through an ethnographic case study, we used event-oriented inquiry to explore video and interview data. The qualitative analysis of the data sources (primarily interviews and video data) revealed that community-based programmes offer the ecological zones that link ecological learning systems in ISE. In addition, her perception of science fuels the tension in her science identity authoring and that this tension is juxtaposed to the tension in her positional identity. Through the lens of the Caribbean diaspora and a science identity nested in figured worlds, this research sheds light on the experience of one Caribbean Dutch girl. The implications of this study provide further
examination of emotions and resilience in science identity and family engagement in ISE research using video analyses.

In chapter five, the final empirical chapter, we present a narrative of how the community-based STEAM-enriched programme offers insight into how resources, which are described as affordances, are leveraged in moment-to-moment interactions across hybrid spaces of virtual and in-person learning environments in a community-based STEAM-enriched programme. Similar to the analytical frameworks of chapter three, we use Holland et al.’s (1998) Figured World and Nasir & Cooks’ (2009) Identity Resources as the framework of this chapter. The main data collected from the study included interviews and videos. The analysis was done using open-coding and focused-coding strategies based on the analytical frameworks. The findings of this study highlight how the children’s experiences in informal science educational settings support their views of themselves. Additionally, the findings underscore the importance of having spaces in ISE for families to safely explore science.

**Significance**

The thesis is expected to contribute to theory, research, and practice in various ways. From a theory perspective, the thesis will propose an evidence-based theoretical framework for STEAM-enriched community-based programmes that aim to support children’s participation in science. From an empirical perspective, the findings of the study reveal the relationship between community-based science learning, children’s engagement, and their self-identification with science through an analysis of them authoring science identities. The findings also showcase how families’ science engagement informs science instruction and how they help to shape (or not) their children’s science identities.

As such, the thesis aims at making a unique contribution to the growing fields of science identity research and ISE in the Dutch context, where they remain largely unexplored. Lastly, from a practice perspective, the thesis provides a concrete example of how a culturally adaptive curriculum can be used by informal science educators to encourage families and children in science engagement.
Chapter 2: An AfroCaribbean science teacher’s quest for healing

A wellness project

Abstract

In this chapter, I present an autoethnographic account of my experiences as an AfroCaribbean science teacher in one of New York City’s public schools. Through event-oriented inquiry and narrative inquiry, I use hermeneutic phenomenology to investigate and explore my experiences. A central focus in these emergent and contingent narratives is the onslaught of emotions I encountered as a racialised “Other” in a majority White context. Emerging from my telling was the urge to embrace mindful breathing and other therapeutic techniques as a way to mitigate my emotions and set me on a path to wellness. A major implication of this chapter is the critical need for science teacher preparation and professional development programs to address wellness techniques and the emotional and physical wellbeing of teachers of colour, Black teachers in particular, as a way to respond to their experienced stress and resulting health challenges, especially in racialised work settings.

*Keywords:* emotions – wellness – mindfulness – AfroCaribbean – autoethnography
An AfroCaribbean science teacher’s quest for healing: A wellness project

Identity, the process of becoming. It is not stagnant or one-dimensional. It is not constructed in a single given moment in time, rather, it is multidimensional, fluid, and ceaseless in its mould across time, space, and context (Varelas, 2012). Hence, in this chapter I describe my Caribbean identity and lived experiences and how through those lenses, I have come to author our science teacher identity and shaped my approach to science teaching and learning. I begin this thesis project by exploring my identity vis-à-vis the contexts where taught and how those experiences have influenced my professional life as an AfroCaribbean science teacher and researcher.

As Etienne Wenger (1998) argues that “our identity includes our ability and our inability to shape the meanings that define our communities and our forms of belonging” (Wenger, 1998, p. 145). I have come to understand my role in my research and the PhD project as one of a “sister outsider” (Lorde, 2012) peering through a particular optics analysing and theorizing about the data and the themes that emerged. Saran Stewart (2019) in framing and theorising Caribbean Feminist Thought captures the intersectional identities of women in the Caribbean and the diaspora. Caribbean feminism raises awareness of the persisting legacies of colonialism on the Black Caribbean woman as well as highlights the privileged and oppressed intersectional identities of being Black, woman, and immigrant. Stewart (2019) has drawn on the seminal works of Kimberlé Crenshaw’s (1989) on Intersectionality and Patricia Hill Collin’s Black Feminist Thought (1991) aiming to disrupt the narrative of the monolith Black woman and to provide a framework “for and by AfroCaribbean women” (p. 153), as we write about our experiences.

In knowing how these identities of privilege and oppression affect our lives, we also have to interrogate the ways in which we can ameliorate the emotional burdens (Avraamidou, 2020b) that we are entangled with and have to negotiate as we persevere in science-related professions. For me that is one of a science teacher and later a science education researcher. In this act of unburdening, I recount my experiences as an AfroCaribbean science teacher in this chapter and discuss the intersections of emotions, identity and wellness while navigating a predominantly white space while perceived as a racialised ‘other’.

There is another aspect that this chapter has engendered for me in this PhD project is to think about how I thought about and sought to create programmes that respond to the culturally-affirming ways of how children, especially children of colour, are authoring their own science identities as they engage with science. The PhD project, ‘Roots: Ik ben Science!’, Roots for short, is a STEAM-enriched informal science programme that took place in a community centre in one of the neighbourhoods in the city of Groningen. The program was designed using asset-based pedagogies such as culturally relevant
Culturally adaptive pedagogies in curricular design and teaching incite a love of oneself, family, and community; encourages children to challenge ideologies that dismiss or diminish the value of their culture, family, community, and ways of being and empowers children to strive for excellence in every facet of their lives (Ladson-Billings, 1995). Ladson-Billings (1995) entreated Black teachers, students, and families to be at the helm of their educational attainment. In designing a curriculum designed using culturally adaptive pedagogies incorporates the family’s and community’s ideas, experiences, and ways of being. Central to these pedagogies is the care and thought about being Black teacher in a racialised world.

Another layer is also the representation that matters in teaching children of colour. A matter of diverse stories and background of participants was important in the development of the curriculum. These are reifications of the values I learnt from interrogating my own experiences, and also unpacking those experiences help to shape my own positioning in science.

In peeling back the multiple layers of science teacher identity reveal the tensions that arise for Black women, AfroCaribbean women, in particular, in our pedagogical and professional duties as science educators. A deeper examination of the intersectional identities under the umbrellaed term Teachers of Colour, in particular, Black teachers, calls for critical discussions around how these teachers are positioned in science education as they are authoring their own science teacher identities and the emotional burden they experience while negotiating their identities. Thriving for wellness is essential in any aspect of one’s overall health, but it is especially critical when navigating the nuances of how racialised bodies in predominantly white spaces. There is a need for teacher preparatory and professional development programs to explicitly address how to support these teachers in reconciling these multiple ways of being.

**Identity, emotions, and wellness**

A salient part of undervalued teacher development is the teachers’ emotions and wellbeing in performing their responsibilities inside and outside the classroom. I include responsibilities outside the classroom since teachers’ professional duties do not just begin or end within the confines of the physical space. Powiełtwyznska, Tobin and Alexakos (2015) argue for mindfulness to be a prominent part of the curriculum in classrooms, science classrooms, in particular. Likewise, students are encouraged to develop a well-rounded repertoire of skills to mediate their world and lead productive lives. In helping students procure these skill sets, what are their teachers’ roles in this process? How are teachers engaging with mindfulness to develop healthy minds and habits as professionals?

In teacher professional development, the focus is on performance targets similar to their students
in mastering content knowledge. This emphasis is evident in the teacher performance targets in the Danielson Framework, teacher rating rubrics and calls for performance-based compensation (Cartel & Lochte, 2017). Teachers’ professional responsibilities extend beyond teaching and learning into the unseen labour of teacher duties that include committee work, sports, and event-coordination, planning and preparation. In this chapter, I advocate for teachers’ emotional wellbeing and overall wellness needs to be a priority in their professional development.

The foci of this chapter are grounded in the emotional state and wellness of teachers in science education, more specifically Black teachers in science classrooms. As teachers shape-shift to respond to the evolution of demands and duties of their positions, they experience varied emotional states that affect their mental and physical health (Tobin, Powietrzynska & Alexakos, 2015). Mindfulness is a purposeful and in-the-moment construct that is sociocultural and multidimensional (Tobin, Powietrzynska, & Alexakos, 2015). The practice allows participants who engage in the exercise to be fully attentive to their affective and emotional states and learn to mediate these states.

For the purpose of this chapter, the participants would be teachers, Black teachers specifically, engaging in this practice for their emotional, mental and physical health. The four basic emotions often studied include fear, anger, sadness, and happiness (Turner, 2009). The high intensity emotional energy that is experienced is born out of feelings invoked and instigated during interactions. In the classroom the teacher and students may experience high-intensity fear and anger or low-intensity fear in the form of concern or apprehension and low-intensity anger in the form of irritation (Bellocchi et al., 2014). Our emotions and how we deal with them are not fixed; they are adaptable and dialogic, emergent, and contingent in and from the interaction (Bakhtin et al., 1994).

Throughout this chapter, I describe the emotions I experienced in my interactions with students and colleagues in our shared spaces. I use the term “shared space” instead of the physical classroom because the emotion-derived experiences I have with my students are not held in suspension in some time warp only to be encountered in the physical space of the classroom. I experience them long after they have occurred. As teachers our professional lives are inextricably linked to our personal lives (Zembylas, 2002), and our teacher | self is intertwined with our sense of self (Rivera Maulucci, 2013). Our sense of self and self-esteem are laid vulnerable to, and, therefore, mediated by our emotions (Zembylas, 2002). Lucy Avraamidou argues that the process of science identity development is emotionally arduous, especially for groups that are systemically underrepresented. Moreover, teacher identity is not stagnant or one-dimensional. Instead, in addition to being fluid and multidimensional, a person’s science identity is forged and evolved within varied social and environmental contexts (Avraamidou, 2020).

In the social realm, our interactions with others mould our identity: how we view ourselves is in
keeping with our interactions with others (Tobin & Llena, 2012). From a professional and environmental stance, a science teacher’s identity is grounded in how we portray ourselves in our viewpoints, orientations, values, beliefs and knowledge of the subject matter and our actions within a particular context (Avraamidou, 2014). Identity, the process of becoming, is diachronic and is not constructed in a single given moment in time (Bakhtin et al., 1994). It is, rather, ceaseless in its mould across time, space, and context.

My place and identity are strongly linked to being AfroCaribbean, an immigrant in the US. As Stuart Hall (2019) has argued, identity is informed by our positioning: the way we are positioned and how we position ourselves in the stories of our histories. These different aspects of identity (for example, being an AfroCaribbean woman and immigrant) have coloured my experiences and have been critical in informing my emotions and professional life in and out of the classroom. My focus on my identity as an AfroCaribbean woman in the US allows for a nuanced exploration of the cultural and racial components in the discussion on emotions and wellness.

With this chapter I intend to further expand on the existing literature in science teaching and learning that raises the criticality for teachers to have opportunities to learn how to engage with and ameliorate their emotions with the overall intent of improving their wellbeing through wellness practices such as mindfulness. Another implication of this study is to shed light on how the emphasis on emotions and wellness can help stem the attrition of teachers of colour from the science education profession, especially Black teachers from diverse cultural backgrounds.

**Methodology**

I adopt a hermeneutic phenomenological framework for this study. As Konstantinos Alexakos (2015) argues, the hermeneutic phenomenological research framework encompasses “a bricolage of methods and methodologies in doing inquiry to explore” and unpack “our lived experiences” (p. 32). Our lived experiences, he continues, are informed by historically- and socially-situated contexts and the interactions we encounter in these places (Alexakos, 2015). The phenomenologists bring their own personal accounts to research knowing that there are possibilities that their own lived experiences reflect the lives of others (Van Manen, 1990). As the well-renowned phenomenologist Van Manen (1990) asserts:

> It is to the extent that my experiences could be our experiences that the phenomenologist wants to be reflectively aware of certain experiential meanings. To be aware of the structure of one's own experience of a phenomenon may provide the researcher with clues for orienting oneself to the phenomenon and thus to all the other stages of phenomenological research. In actual phenomenological descriptions one often notices that the author uses the "I" form or the "we"
In this regard, using heuristic phenomenology allows me as the researcher to ask questions of ‘how, why, and what’ of my own AfroCaribbean lived experiences in a predominantly white context are informing my pedagogy and positionality as a science teacher. It also guides my inquiry into researching and theorizing the ways in which others who share similar identifiers of being part of a diaspora and a group that is traditionally marginalised in society might be authoring their own science identities as they participate in and pursue science-related professions.

In answering these questions, I use a bricolage of methods to analyse my story. Bricolage according to Kincheloe (2011) affords the researcher “multiple methods of inquiry” (p. 180) into the data. Bricoleur is “taking place within and without disciplinary borders”. Offering up a methodological inquiry that employs “multiple ways of knowing, and to embrace a set of value dimensions” (Luitel & Taylor, p. 193). Using a bricolage of methods of inquiry provides different frames from which one can view and investigate the phenomenon that is being explored. In the next section, I explain each methodology of inquiry that I employ in my analysis starting with autoethnography, then event-oriented and narrative inquiry approaches.

**Multi-methodological inquiry**

Autoethnography serves as a positive response to critiques of the traditional canon of what research is and should be. This methodology acknowledges and accommodates subjectivity, emotionality, and the researcher’s influence on research, rather than hiding from these matters or assuming that they do not exist (Ellis, Adams & Turner, 2011). How can I best express the nuances of teaching? Autoethnography provides an answer to this question. It allows the researcher to share stories that readers can connect to and broaden their own understanding or gain insight. A strong critique of autoethnography is its ability to provide generalizability and validity in research. Critics of the methodology argue from a positivistic stance where the subject is separated from the research. However, as Ellis, Adams, and Turner (2011) have countered, the reader provides validation as they read and connect with stories. These stories elicit more than relatability but provide continuity as they bring to light cultural practices that may be relevant to the wider society. Furthermore, to echo Tobin’s (2000) position on generalizability in ethnographic studies, the purpose in my pursuit is interpretive and the aim is to find out what happened and why it happened from a perspective of one: my own lived experience.

Phenomenology asks the “what, why and how” of the phenomenon under study (Kola, personal communication, June 19, 2023). Thus, in addition to the use of autoethnography account, I employ Tobin and Ritchie’s methodology of event-oriented inquiry to allow for the emergent and contingent around “what is happening, why is it happening, and how changes might be made to afford positive,
collective and individual changes” (Tobin, 2015, p. 3). Working with multiple forms of inquiry affords thicker descriptions of what is happening and broadens the scope on why it is happening. The interpretation I deduce from what and why will be knowledge gained in the body of research on how to improve science teaching and learning.

On top of event-oriented inquiry, I also employ Jean Clandinin and Michael Connelly’s (1996) narrative inquiry. Narrative inquiry allows the researcher to paint a picture as we move from different frames. One frame is our “work in the field,” then we move to our second frame, “… from the field-to-field text.” Field texts are our recollections of what happened in the field. Sequentially, we move from the third frame of the recollections of what happened in the field to the final frame of moving “… from field text to research text” (p. 60). In moving to the third frame we are interpreting, analysing, and theorizing as researchers of what happened in the field. Moving between these frames is not a linear but cyclical process as these frames afford us, the researchers, a three-dimensional frame to look “inward, backward, and forward within a situated in place” (p. 49) across space and time (Clandinin & Connelly, 1996).

In the coming sections, I share narratives by describing particular events that occurred during the span of time I spent as one of few Black teachers and AfroCaribbeans on staff at a middle school in one of the more affluent neighbourhoods in Brooklyn, New York. In keeping with the adopted frameworks, I use autoethnography, event-oriented inquiry and narrative inquiry as methodologies to share my experiences. To draw on these inquiries, I include email correspondence and stories to capture significant events of my time at the school and shed light on the varying emotions I experienced and how I strove for wellness over the course of time. The identifiers in the emails and stories have been changed to maintain anonymity.

**Brief Pause**

Where does it hurt? In my inner soul, my inner being like ... What does it feel like? It feels like a fractioning of who I am: a loss of my self-confidence and self-worth and like feeling less than. Right. That’s what feeling less than brings about: pain. Because you are experiencing this pain that you’re going through, this, like onslaught of not being enough in the space you are. The pain of never being enough, right? Never being enough in the space and always trying to prove otherwise. [You feel as if you are an interloper] working hard to prove that you belong. In this space. In this space not only a teacher, but as a science teacher. Always proving that you are, proving that I am capable of doing it. I am doing it. And, also, trying to prove that I should be accepted. Right. So always like this. So that’s what I wanted to convey, that this: trying to prove your worth all the time. So, I belong here, so I need to prove to you that I belong here, and I need other students to know that they need to prove to the world that they belong there too.
Wow … it is more difficult than I thought. The above epigraph was shared in one of the research squad meetings. I was encouraged to follow the feeling and say how I felt about my experiences and what I wanted to convey in this chapter. Initially, I had started writing the reflections that are to follow in the coming sections of the paper on a long bus ride from Virginia to Washington D.C. I was on my way back from a conference hosted by the Science Education, Equity, Diversity and Social Justice (SEEDS). I was amped from the conference and more motivated than ever to share these narratives. My story could offer insight for new teachers on how to mitigate their emotions and ensure their wellbeing, especially in contexts that are racialised and oppressive to their humanity. In the words of Hall (2019), I was excavating and unearthing the overlaid, hidden and suppressed. But sharing was not easy. I realised quickly that writing these reflections was more than letting the words flow. I was reminded of Leah Pride who shared quite candidly the jarring process of writing her dissertation and of how she cried and wrote and cried and wrote (Pride, personal communication, July 16, 2019). Her tears became the ink in her pen as she wrote about her experiences as a woman of colour, a scientist, and a science educator (Pride, 2018).

The Events That Led to Inquiry

In the coming sections, against the backdrop of varied encounters in different instances in my time as science teacher in a predominantly white teaching staff and student body, I discuss the need for attention on emotions and wellness for Black teachers and by extension their Black students. My experience becomes racialised through my embodiment of Blackness and Caribbean-ness in the white culture that undergirded the school environment.

The Token Other

The following is an email response I wrote to a former classmate from our Master of Arts in Teaching (MAT) degree program. I wrote and sent this email when I was in my first year of teaching.

They had me come in to teach on the last day of school to do my demo lesson, and they hired me. I heard they said they liked my spirit … whatever that means. But it has been hard Jay. I never realised working in the professional realm can be so emotionally draining. I love teaching kids. Jay, I am one of three black women in the school and the only Caribbean nationality on the teaching staff. The two paras are of Caribbean descent. This was my biggest hurdle to get over. There were some days I felt lonely, and I didn’t like the feeling. And one morning I cried in the shower when I realised how isolated I was feeling. BUT I am coping and allowing myself to be open to change and stepping out of my comfort zone, timidly of course. Also, it is a great school, and the kids are amazing.
I felt tokenised. I felt I was a token hire and would spend the next four years proving to myself and everyone else that I was more than qualified for my job. Ironically, among the new hires that year when I joined the staff, I was hired after doing a panel interview, a demonstration lesson and a debrief and follow-up interview after the lesson on the last day of the school year. Another new hire that year, a young White woman, also a newly minted teacher, was invited to join the teaching staff after only one interview. No demo lessons. No follow-up interviews. And I am the one who felt like a token hire!

The feeling of having to prove myself was mired in how Black and other bodies of colour and intellect are scrutinised in professional settings, education, and the classroom notwithstanding. There is a hyper-visibility and invisibility that goes with being a Black body in a predominantly White space. My very presence was an intrusion that disrupted the normal that underpins the culture of whiteness in the classroom and larger school environment (Yancy, 2014).

It was important for me to have other Black teachers and Caribbean teachers for support. An affinity group to be exact. This has been an underlying tension throughout my experience in the US. I needed these spaces and opportunities. In my undergraduate and graduate studies, I had these spaces and friendships, and I drew on them as a source of strength to persist. Alexakos (2011) argues that fictive kinship groups (close personal friendships similar to familiar ties, like calling each other brother or sister) provide the positive emotional feedback and an environment that fosters successful coping skills, perseverance and resilience among the group members. Having the affinity group was not a singular experience. The support such kinships provided was an undercurrent in my experience throughout my undergraduate and graduate programs. I could depend on this community of Black women for emotional support and relief, especially considering the fact that these programs did not boast a large representation of Black women. Although we were small in numbers, our solidarity fortified our resilience and resolve to persevere. For me, to be working as a teacher and be one of very few Black people on staff rang loudly that the school was not my place. I felt a sense of loneliness that sapped my energy. I needed to remain resolute and not break under the gaze of others. However, to conjure up that inner strength day in and day out left me emotionally and mentally tired.

The myth of meritocracy: Stinkin' thinking

The following excerpt is an email I sent two of my teaching colleagues following a book club meeting. We were reading Beverly Daniel Tatum’s (1997) seminal book on the psychology of racism in schools, Why are all the Black kids sitting together in the cafeteria? And other conversations about race. In the meeting, I had spoken about two separate encounters with two Black students I taught. After being called out by a couple of the other teachers, I reflected on how I, as a Black teacher,
engendered micro-aggression and micro-violence against other Black students.

So, yesterday, I was all micro-aggressing: Calling Axel loud and telling a 12-year-old child to stop being who she is. I have to reread it myself (for obvious reasons), but the article talked about how black girls in schools are subjected to middle-class whiteness as the “correct way of being.” And Much More. Signithia Fordham (1993) wrote a book about the concept as well.

Joyce Meyers is a preacher, author, and founder of Joyce Meyer Ministries. She uses the phrase, “stinkin’ thinking” quite often in her sermons on getting your mind right and living a God-fearing life. She would admonish the audience, including those tuning in on television or the internet, to change the way they thought in order to have a better life. I listened to Joyce Meyers religiously during my undergraduate years. She had a sermon series on “Excellence and Changing Your Mind.” The ideas of digging deep and pushing on came from many of her sermons coupled with my own upbringing. Dig deep. Change your mind. Unfortunately, I brought these very shame-laden mantras into the classroom. My students of colour, especially the Black girls in the room, would feel that pressure of pushing the envelope and challenging their thinking. The pressure on girls of colour, Black girls, being one of the few in the room, afraid to make a mistake, would opt to remain silent and not participate because the pressure of getting the answer wrong is too great a burden to even attempt a response. Responding carries too great a responsibility should you get the answer incorrect and reflect poorly for an entire Black community.

These sentiments were not foreign to me. I felt this way in most of the science courses I took as an undergraduate student in the US. And, worse, my middle school Black students experienced it. The diversity committee, at the school, had launched an affinity group-type club called Pretty Brown Girls¹ for Black and Brown girls at school. In our first meeting, some of the eighth-grade girls whom I had taught the previous year, shared how much they felt this burden of their actions, especially their academic performance, reflecting negatively on the Black community. These girls were 13 going on 14 years old. They had not even begun to realise their full potential and were already plagued by this deficit-oriented perspective. Upon hearing this I was shocked, angry, and embarrassed. I was angry that the girls, so young, carried such a burden; I was embarrassed and angry at myself for also perpetuating this myth of meritocracy in my classroom.

Frazetto (2013) describes anger as fear cloaked in armour. Anger is a spontaneous or a slow-seething defence that is there to protect the self from any offense or ill-will. Fear and anger arise when we need to defend ourselves against something or avoid it. However, when anger is reflected unto oneself, we feel guilt. Guilt arises when we have brought harm to someone else; it is our moral compass. Guilt arouses shame. The shame of disgust with oneself, feeling inferior and unworthy (Frazetto, 2013). I was well aware that I had been unfair to my Black students, especially the Black girls. In the name of
good intentions, I was stricter and demanded more of them. They were not happy nor was I. Looking back, I feel I had created a miserable and unsafe class environment for the very students I had desired to support.

In their article on “Mindfulness and discussing “thorny” issues in the classroom,” the authors in citing Zembylas’ work on “grievability and vulnerability,” caution that in being aware of our responsibilities as educators is that there are also shared responsibilities, although asymmetrical, in who is being victimised versus who is the victimiser (Alexakos et al., 2016, p. 746). Based on how we negotiate the self | other dialectic, there are multiple ontologies. What emerges from these multiple ways of enacting, one can be under duress, experiencing violence, from systematic oppression whilst simultaneously being an offender. For my students and I, the Black students especially, we occupied two sides of the same coin in this racialised stew of wanting to and pushing to be better to counter the narrative that Black women and girls are not as successful in science as their White peers.

Fortunately, I had the opportunity to apologise to some of these Black girls. Expressing my sincerest apology was the best way, I thought to make my students aware that this behaviour is wrong, and they should be celebrated as who they are. In the name of high expectation, I had created an atmosphere where I pushed my students to strive for values that were not entirely their own instead of celebrating what they had to bring to the lesson. They were more than enough. Steele (2010), in his seminal work on stereotype threat, argued that for Black students, the need to prove or disprove the stereotype of having less cognitive abilities than their counterparts in class engage in what is described as “over-efforting.” What the students aced was persistence: they persisted and tried twice as hard to disprove the negative label reinforcing the old adage “Black people have to work twice as hard to prove themselves as worthy.” What Steele (2010) and his fellow researchers found was that when students were under stereotype threat, the pressure increased to disprove the negative stereotype about their intellectual abilities compared to their White classmates.

Wellness and teaching: “Something’s gotta give”

I was feeling this state of being out of control. No matter how much I would dig my heels in and persevere, I still felt unsatisfied with the progress I had made as a teacher and the general state of affairs of the Black children in the school community. I felt as if I were running in place without making any progress: I was running faster and faster but felt stuck in the same place. I was experiencing the Red Queen effect. This hearkens back to the famous story of Charles Lutwidge Dodgson’s (pseudonym Lewis Carroll) (1865) Adventures of Alice’s Adventures in Wonderland’s Red Queen Effect analogy used in biology textbooks to discuss the human fight against bacteria and viruses. Scientists are tackling a major battle where bacteria and viruses are evolving into stronger strains that are resisting our strongest
synthetic drugs. This is how I felt: I was stuck.

We had come a long way as a school community. The administration was committed to overhauling the admission policies and disrupting long-standing inequalities in our school. But I felt like I still had to push. I was fighting an inner demon that was engulfing me. I saw the inequalities in performance in my classroom along racial lines. There were very few Black students in the general education classes where the higher performing students were grouped with one teacher compared to their greater numbers in the classes that were co-taught and had more students with Individualised Education Plans (IEPs), a characteristic of special education classes. I raise this point not to belittle the importance of co-teaching and the need for some children to have a community that supports their academic growth. On the contrary, in the US, Black and Brown students are under-represented in gifted or honours programs but are overly represented in special education classes compared to their White counterparts, a striking evidence of inequality in education (Ford, 2012).

In my second year, the school’s administration had procured the services of a racial diversity training organization for a year-long diversity training with the staff. It was a gruelling process. The following year, the school hired more staff members of colour and committed to reshaping the admission policies and prepared plans to offer algebra regents to all students. Even with a more diverse staff and commitment to racial diversity, I still lacked a sense of wholly belonging.

I was working harder but I was crashing. I had over-committed to too many things. I was spending longer hours at school and my emotional, mental, and physical health were in turmoil. The last two years of teaching at the school, I was rarely without a cold. Yet, out of those four academic years, I took two sick days: once when I had strep throat in my fourth (and to be the final year) and in my first year when I left half a day early because I was too ill to continue teaching and remain at work.

I felt like I was drowning …

I was alone in the classroom; the building was deserted. The after-school staff had left, and the custodian had already cleaned my side of the classroom. I could not breathe. That’s how it felt. I was inhaling as deep as I could, trying to fill my lungs to their greatest capacity but instead, my chest felt tight like it would burst open. I could not breathe. My mind raced. Calm. Down. Breathe. I flung open both of the classroom’s doors, pushed up the two windows that could actually be opened and unhooked my brassiere. I needed to breathe. To fill my lungs with air. I was having my first panic attack. At the time, I did not know it. I was scared. What was going on? My family’s health history was one riddled with all types of lifestyle-related illnesses, hypertension being the most common. Both my maternal and paternal grandfathers had passed away as a result of a heart attack. Was some family trait of poor heart health finally presenting itself?

I would have more of these episodes over the course of the first half of the school year. I was in
my fourth year of teaching. I had one on the way to a Professional Development in the Bronx. Because of this one, I had stopped taking the express train and rode the local line that had more stops and more chances of escaping to safety and fresh air if I needed to. The packed number 4 train during rush hour had stopped in between stations. A wave of panic overcame me as I could not breathe and felt like I was suffocating in the packed car. I remember craning my neck above many of the other people’s heads to try to breathe in big gulps of air. As soon as the car had pulled into the station, I bolted for what felt like safety on dry land. I remember how helpless I felt. I texted my friend to share what had happened to me. He tried to reassure me that everything would be all right. I just felt helpless. I sat on one of the benches on the platform to collect myself. Once I felt like I could breathe normally, without strain, I got on the next train that was not as crowded. I sat there scared and feeling out of control. I sat in that car, breathing deeply, tears streaming down my face as the train rolled out of the station heading to the Bronx.

Meditation and yoga: “The tipping point”

As a student in the Adolescent Science Education program at Brooklyn College (CUNY), our advisor had challenged the way we thought about educating our students and cared for our health as educators through his use of mindfulness in the classroom and focus on co-teaching experiences. In most of the graduate classes, we practiced several minutes of mindful breathing before class began. I used the word “challenge,” as my Pentecostal Christian upbringing had cautioned me to avoid meditation and yoga practices which were perceived as conforming to Buddhism. In those early days of classes, I would join in the practice and quieten the admonitory inner thoughts that I was shunning the third commandment: Thou shalt have no other gods before me, Exodus 20:3, KJV.

Regardless of my religious reservations, I was aware that being mindful of my emotions, or even, my breathing was a skill to develop in my teaching practice. As part of the course requirement, we also attended the monthly Urban Science Education Research Seminars (USER-S) at the Graduate Centre (CUNY). At those meetings, I would learn more about the importance of mindfulness in education. I vividly recall a speaker, at one of the seminars, had shared how he was mindfully walking on his way to USER-S that morning. He continued to explain how he developed the practice of being mindful over time. He would let thoughts in and let them go, allowing himself to freely let go in those moments of deep breathing. He then led the seminar attendees in a few minutes of mindful breathing. These experiences were not my only introduction to mindfulness practices. One of my first-year co-teachers, also a longtime participant at USER-S, practiced mindfulness in the classroom and some days would take out her chime bowl and lead the students in quiet meditation.

These foundation years of dabbling in mindful breathing and meditative practices were to become my cornerstone rituals for surviving during my fourth year of teaching. At first, I would try it on
my own but felt my thoughts would wander too much. I then tried different meditative YouTube videos until I settled on meditations by The Honest Guys (2014). This became a ritual. “Rituals are constructed from a combination of ingredients that grow to differing levels of intensity” that leads to “outcomes of solidarity, symbolism and individual emotional energy” (Collins, 2004, p. 47). My ritual was to begin my day with five minutes of meditation and five minutes of gentle yoga. Gradually, I increased my time to 10 minutes of meditation and 15 to 30 minutes of yoga. I engaged in these two practices not as a fad but for my survival. There were some days at school when I needed those five minutes. Moments when I experienced high-intense emotions, I would gather my necessities: my yoga mat, cell phone, earphones. Crouched down in between cupboards and carton boxes full of science supplies, for those five minutes, I sat, listened, and breathed deeply.

In my earlier years of teaching, I had other ways of coping. I would listen to India Arie’s, “Strength, Courage and Wisdom” on repeat or a gospel music mix on those more difficult days. For AfroCaribbeans and African Americans, religion and spirituality are the more likely options for dealing with stressful situations than seeking mental services (Chatters et al., 2008). Older adults in these demographics are especially resistant to choosing these services and are more likely to opt for prayer and speaking with their pastors to cope with stress rather than pursuing mental services. I had been praying, listening to gospel music and sermons. However, I felt like I was only avoiding dealing with the underlying issues. My immunity needed a complete overhaul.

Therapy and acupuncture

I had reached out to my therapist as early back in 2016 after a friend referred her to me. I had contacted other therapists over the summer but was not too interested. They were not who I was looking for: I wanted to work with a Black woman, preferably Caribbean. She fulfilled both criteria. However, I learnt that she did not take my insurance and I tabled the idea to see a therapist. Fast-forward to the following school year. I knew something had to be done. I was teaching other people’s children (an ode to Lisa Delpit’s book, Other People’s Children). I felt like I was losing the handle on my sanity. I searched my email inbox for her number and called her outside the school building during one of the breaks. I was near panic because I thought I was having a psychotic episode. So much so I was willing to pay out of pocket to see her. My first session with her was on October 10, 2017.

Hi Theila,

Thank you for your interest in my practice. I can meet with you to discuss the possibility of working together; however, my office days are Tuesday, Thursday and Friday. At this time, I have openings at 6 pm and 7 pm on Thursday and 6:45 pm on Friday, and before 4 pm on Tuesday and Thursday. Please let me know if any works for you.
My therapist engages in psychoanalytic therapy which has major benefits. However, it is a slower process compared to cognitive behavioural therapy. I was functional at work and that is what I needed. My emotions were still raw although I was not as scared as I was before. One of the things therapy does is stir up (unwanted) emotions and memories. The kinds that had been neatly and tightly wrapped and tucked away deep in the unconscious. I then decided to seek out another method: acupuncture. To my therapist’s annoyance, I decided to go to acupuncture to help ease the sadness and pain I felt from some of the sessions. Apparently, you are supposed to work through them to offer you release. I was adamant that the process of working through was much more than I could handle, and I needed something else to numb the pain. Acupuncture seemed like the safest alternative.

I remember after my first acupuncture session when I stepped outside the building, breathing in the cold air, I realised my sinuses and nasal passage were clear. It had not occurred to me all day that I was congested. I inhaled a deep-lung-filling gulp of air. Standing there in the cold that late winter evening, I breathed in the frigid air that felt like it filled my entire body. I breathed in deep gulps as if I were without air for a long time. Upon reflection, this experience might have been a metaphor. I was hitting the reset button for a more mentally-well chapter in my life. In that same session, during the intake process, when my prospective acupuncturist asked what I wanted to work on, I replied without hesitation: my anger. In those successive sessions, I was able to let go of all the built-up anxiety and frustration from that day and the week. I would liken this experience to a slow pressure release as I mindfully let go of all the lingering thoughts and emotions for that hour.

Others’ stories

Among the myriad of emotions, I was experiencing that year, I also felt a deep sense of shame. Frazetto (2013) argues that shame, a deeply-ingrained emotion conjures up feelings of unworthiness, inferiority, and inadequacy. So, why was I feeling this sense of shame?

I do not have a clear answer. However, I do know I felt like I was failing and was worried all the time others could see through my façade. I, the imposter, was always on the brink of becoming exposed. In her dissertation, Pride writes descriptively about imposter syndrome, giving it a persona of double consciousness³ the ‘other’ who wants you to remain invisible and be left mired in obscurity, fear, and doubt. She describes imposter syndrome as a debilitating state of emotional, psychological, and physical duress that kept her emotionally imprisoned, enslaved, “bound and restricted to fear and shame” (2018, p. 4). The imagery captures so palpably the tokenised imposter that shackled me: that is, fear. The one that immobilises and renders us powerless. The emotional state of fear, the most intense and briefest disrupter to social life, what Collins describes as an emotional response of “one being coerced or excluded” (2004, p. 129). I was suffering in silence and sometimes it was deafening.
In her chapter on mindfully discussing race, privilege and social justice, Pride takes her readers through a breathing technique to help them mindfully process the intense emotions transferred from writer to audience (Pride, 2018). Here, I too invite readers to pause and take a deep breath.

**Take a deep breath in through your nose and exhale out through your mouth. Inhale in, exhale out.**

Collins discusses that emotions are necessary in the build-up that led to some form of solidarity and emotional entrainment. “The emotional-laden cognitions that become ingredients for the upcoming encounter, feelings of membership and solidarity” (Collins, 2004, p. 105). The crucial emotional ingredient for me was fear that linked my experience to others’ stories and created feelings of solidarity. I began reading the blog posts of the Anxious Brother, a fellow Brooklynite, who shared quite vividly about his experiences with anxiety and mental illness. I felt his raw emotions as he opened wounds and extreme pain in the cathartic writing process. I read teacher blogs that talked about anxiety or burnout. I read anything that would give me insight as to what I was experiencing and feel a part of a community.

I once came across an inspiring blog post in Mrs. D’s corner, a teacher blog that offered lesson ideas and other discussion topics. The blogger detailed how she had to take a break from teaching to **recover from teaching**. Reading her blog post on the train ride to work that morning was an inspiration (the emphasis in bold was in the original article):

Teaching is tough, and it’s okay to take a step backwards. Your decision to leave your current teaching position does **not** define you. Your struggles do **not** define you. Your anxiety or depression does **not** define you. Your decisions to take care of yourself first do **not** define you. Teaching does **not** define you, and neither does your classroom. (Delussey, 2018)

I did not return to the classroom in the following school year. However, I did not leave education, all together. Instead, I am pursuing a doctoral degree at the University of Groningen in the Netherlands. And I am still teaching in some capacity: I have taught a summer course at Brooklyn College for the past two summers and I work with young children as part of my research project, a Saturday STEAM-enriched program called Roots: “Ik Ben Science.”

My main focus group in Roots is Afro-Dutch Caribbean children. A similar deficit discourse serves as the backdrop to the academic performance and career aspirations for the Dutch Caribbean community in the Netherlands, particularly in the sciences. For me as a student researcher, I want to centre their resilience and aspirations. I, also, want to learn about their love for science and share mine; to explore their interactions and positioning not from a reference point of where they are less than, but more so, what they bring to and impart with others in space. As for me, I am unclear of where I will plant roots next, but similar to the experience I hope to create in the program, it will be a place where my personhood and humanity are valued and respected.
Resetting the path to wellness

Dear Black Teacher,

Reclaim your true essence. You are more than enough. You are born with a purpose on this earth, and you matter. You bring all of yourself to your profession and that is more than enough. You matter and belong in the spaces you choose to lay a foundation. You deserve to be your full self in your profession.

Reclaim the fear and let it become what empowers you. Caste away all your fears and embrace a spirit of love, power, and a sound mind. Once you can move beyond fear and harness the power within you, you can move boldly forward. Reclaim your humanity. You deserve to be healthy. Mindfully engage with your emotional, psychological, physical, and mental wellbeing. If it works for you, practise daily affirmations, meditation, and deep breathing. Find what works for you. Find a path to your overall wellbeing because you are worth it.

In Solidarity,
An AfroCaribbean Science Teacher
Notes

1 I want to thank Mariatere Tapias-Avery, a member of the research squad, for making a salient point by asking the question: “What does it mean to be a pretty brown girl?” Does this mean if a child falls outside the narrow definition of what is considered beautiful in the American context, then they are socially ousted from this affinity group?


Chapter 3: Culturally relevant/responsive and sustaining pedagogies in science education: Theoretical perspectives and curriculum implications

Abstract

The main focus of this paper is to put forward an argument about the value of asset-based, culturally relevant/responsive and sustaining pedagogies (CR-SP) in science education, especially in former colonial contexts. Countering the framing hegemony of science education through a historically Euro-dominant lens, we call for a critical analysis of the state of science education in the Netherlands by exploring, specifically, the Dutch Caribbean community which includes Suriname and the former Dutch Antilles and Aruba and the need to respond with a more culturally relevant and sustaining pedagogical stance. In doing so, we provide a concrete example of a CR-SP-focused community-based STEAM program for young children and their parents in the north of the Netherlands. We hope that this paper will provide the foundation to springboard conversations among educators and researchers with an interest in designing, enacting, and researching CR-SP-informed programs and curricula geared for historically marginalised families and children.

Keywords: Cultural adaptive pedagogies, Dutch Caribbean migrants, Community-based program, STEAM
Culturally relevant/responsive and sustaining pedagogies in science education: Theoretical perspectives and curriculum implications

As one decade faded and we welcomed the dawn of another, we are still witnessing the dis-enfranchisement of groups of people based on who they are, where they live and what they believe. We witness genocide in another name and dog whistle politics that continue to frame and reframe who is considered “the Other” in society, especially in postcolonial and settler colonial contexts. For example, in the USA, the UK and Brazil, contemporary political trends have re-energised the racialised discourses that contribute to ongoing violence against Black and Brown people. In the Netherlands, which serves as the context of this paper, there exists the infamous holiday tradition of Zwarte Piet—the blackface helpers of Sinterklaas, a tradition that has embodied ridicule and degradation of Black people (Wekker, 2016). Moreover, a few European countries (i.e., France, Belgium, and the Netherlands) have implemented Islamophobic policies that prohibit the use of the burqa and niqab in public spaces (Guy, 2019).

Separate from Islamophobia, we witness xenophobia at the highest levels of governments. For example, in the wake of the most recent global pandemic, in the USA, during the Trump presidency, the past-president and other top-level officials in his administration referred to COVID-19, commonly known as the coronavirus, as the “Chinese virus.” When the earliest reports surfaced that the outbreak of the virus occurred at an animal market in Wuhan, China, Asian communities in the USA reported heightened bigoted attacks where the racial epithets were certainly encouraged the onslaught of assaults (Yoshiko Kandil, 2020). This racialised and bigoted language is not new to the political arena: the Reagan-era presidential campaign saw tropes like the Welfare Queen used to caricature African American women and by extent their communities as unfairly gaining from social welfare (Bennett and Walker, 2018).

Xenophobia is also evident in the turn against immigrant communities with increased deportation seen in the Western countries such as the USA, Canada, Germany, and the UK (Gibney, 2008). In the UK, for instance, there are recent mass deportations of Caribbean nationals. Ironically, some of the people held by the UK Home Office are of the Windrush generation from the English-speaking Caribbean who were brought back to help rebuild Britain after the second world war (Ott, 2020). What is now dubbed the “Windrush scandal” is an indelible stain in the UK’s timeline of recent happenings. In like manner, the US Immigration and Customs Enforcement (ICE) raids are carried out on a sweeping scale in immigrant communities where some of the people detained were, in the first place, seeking
refuge in the USA from civil unrest and natural disasters in their home countries.

As we observe decades of Islamophobic, xenophobic and racist attacks coming to the fore during spurts of human turmoil, it is evident we have not yet slain Goliath; we have not even maimed him. The legacies of the colonial projects are still steering policies in every sector of society, education notwithstanding. This is further amplified in the science classroom where science is positioned as objective, ignoring the colonial legacy that is embedded in Western Modern Science, the science that is the foundation of the school subjects (Adams et al., 2020). With science, in general, being an understanding of the natural world, it is plausible that students from different cultures will have diverse understandings of how the world works. However, experiences that are not aligned with the dominant culture of the classroom are all too often dismissed. Students’ voices are delegitimised based on a false sense of who they are or what they can contribute to the science classroom.

Historically, it is the voice of the marginalised groups that are often silenced (hooks, 1994). As a matter of fact, because science is quite often presented as neutral, judgment-free and apolitical, it masks the ongoing silencing and marginalizing of non-dominant students in science classrooms. This contributes to the longstanding issues of diversity in the sciences, especially in postcolonial and settler colonial contexts. In this paper, we argue that if we are to make science-spaces that welcome and value diverse worldviews, we need to advance a critical awareness of contextual structural inequities and then explicitly design science learning to resist and counter these systemic barriers to equitable science learning. This calls for a reconceptualization of questions related to what is science, whose science, whose knowledge, and science for whom? (Harding, 1991).

The urgency of centring non-dominant voices in science education

These questions become more relevant as the world is faced with contemporary socio-scientific challenges, such as poverty, inequalities, climate crises and global pandemics. Racialised and other marginalised groups around the globe exponentially experience the negative effects of these issues. As such, it is increasingly important for critical science educators to ensure that all voices are heard and brought to the centre of scientific knowledge production and decision-making. In other words, it is important to re-centre the science of being human, locating scientific meaning-making and knowledge production as connected to human lived experiences (McKittrick, 2015).

Critical researchers have been using frameworks that centre non-dominant voices in science education. Norma Gonzalez, Luis Moll, and others (1995) forwarded the funds of
knowledge to describe the range of resources that Latino/a/x have access to in their families and communities and could be used to support student success in school. Similarly, Tara Yosso (2005) proposed the community cultural wealth knowledge to counter the deficit perspectives of students from non-dominant groups while highlighting the cultural assets that they bring into the classroom. Strong et al. (2016) outlined a critical transdisciplinary heuristic to counter neoliberal approaches to science education and expand agency for learners in ways that allow them to see layers of culture, power, and knowledge in their local environments. In these asset-based approaches, researchers call for learning that centres diverse experiential perspectives, values multiple ways of knowing and advances the agency of learners from non-dominant groups.

**Purpose**

In this paper, we foreground the importance of articulating and enacting asset-based pedagogies (Paris, 2012) in science teaching and learning experiences for students in the context of the Netherlands. Culturally relevant/responsive and sustaining pedagogies (CR-SP) embrace a polycultural approach to science education with an emphasis on centring and supporting marginalised students’ participation in science. The Netherlands is of special interest given its colonial past and the disengagement of the educational research community with post-colonial debates. As we will argue later on, educational research has remained neutral and apolitical despite the country’s colonial past and the multicultural nature of contemporary Dutch society.

Our argument is rooted within critical theory, which offers the structure to make visible and critique the systemic oppression in the institution of education that becomes a directive force in supporting some students while marginalising others. In this paper, we outline the history of these culturally adaptive pedagogies: culturally relevant (Ladson-Billings, 1995), culturally responsive (Gay, 2002), culturally sustaining (Paris, 2012) and culturally sustaining/revitalizing (McCarty & Lee, 2014). In tracing the history of these pedagogies, we argue for the value of using these culturally adaptive approaches for the purpose of promoting goals related to equity and social justice in science education in the Netherlands, which remain unaddressed.

**The hegemony of science and science education**

With a closer, albeit brief look at the social constructs of race and gender, we can begin to see the ways in which whiteness plays a hegemonic role in science education.
Frantz Fanon (1952/2008) argued, in his book *Black Skin, White Masks*, that the Black man is striving to be white because, in essence, to be a white man is considered to be a *man*, to be human.

In Katherine Mckittrick’s (2015) book, *Sylvia Wynter: On being Human as Praxis*, an edited collection of essays thematically centred around Sylvia Wynter’s writings and essays, she discusses the author’s explication of the yardstick of *what it means to be* and *who is* human. To be Man, is hierarchical and relational where the colonised-non-white-Black-poor-jobless-(female-queer) underclass is condemned to a ‘naturalized’ dysselected human status” reinforcing the socio-political oppression that pathologises whole groups of people (Mckittrick, 2015, p. 7).

Kaima Glover (2016), in her review of the book, extends the description of the underclassed to include “female and queer” (p. 145), which we have adopted in the preceding quote in parentheses. To deem a group of people intellectually inferior and primitive gives license to kill, rape, destroy and exploit without moral conscience. If one is less than human, then following the anthropocentric way of viewing the world, one is like an animal or plant to be dominated and commodified as a product in economic pursuit—no harm committed. Wynter (2003) pointed out that the binary human/subhuman in North America is predefined and the Category Other embodies the lack of traits and qualifications to be human and North American.

We extend this definition to being human and European. The classification of being human is “to be white, of EuroAmerican culture and descent, middle class college-educated and suburban (Wynter, 1994, p. 43). Therefore, the woman, immigrant, Black, Brown, ethnic white, disabled, transgender, poor “jobless school drop-out/push-out are “perceived to be, and therefore behaved towards” as the categorical other subhuman (emphasis added in original work) (Wynter, 1994, p. 43).

Atwater (2000) critiques that topics on gender and feminism position white girls and women at the centre of those conversations. Atwater (2000) goes so far as to assert that gender is a “code word for white females in science education” (p. 386). Her refrain of Sojourner Truth’s question of *Ain’t I woman, too?* is reminiscent of the constant struggle Women of Colour, specifically Black women, face in the conversation on gender in science education. This struggle is the seemingly unheeded call of marginalised women to be considered on equal standing with their white counterparts. In the preceding argument, the use of the word gender highlighted the anatomical features of sex, female or male. However, gender can be defined as a culturally constructed biological trait, behaviour, and
expectations of what a certain culture defines as femininity or masculinity (Brotman & Moore, 2016).

In a review study, Brotman and Moore (2008) analysed the major shifts in gender and science over a 12-year period from 1995 to 2006. The review looked at four themes in the approach to engage girls in science. In the major shifts from the 1990s, when researchers shed light on the fact that there still needed to be major work undertaken in focusing on gender in science education, it still took years later for the discourse to examine other intersections in the conversation around gender and equity. Similarly, in her book, *Teaching to Transgress*, hooks (1994) discusses the historical, social, and political context in which Black women and white women operate and how this milieu impacts the relationship and scholarship of Black women in feminists’ works. To situate the conversation, the backdrop of the socio-historical and political context in which Black and white women operated had to be deconstructed to fully grasp the critiques Black feminist had of gender studies.

Similarly, with researchers in the field of gender studies, to fully deconstruct science, we have to explore the sociopolitical and historical role of practices in the name of science in communities of minoritised groups. The call for science for all in the science education community is well intentioned; however, it cannot be attained if the institutionalised oppressive regime of the historically positioning of marginalised groups is not explicitly acknowledged, addressed, and resisted.

In light of this critical feminist deconstruction of gender, in this paper, we offer criticism to the positioning of people of colour, in particular Black people, and their relationship with the culture and practice of science. The violence against Indigenous peoples and other groups at the fringes of society as well as the erasure and appropriation without credit of knowledge, culture, practices in the name of science has to be explored in an attempt to decolonise the field of science education (Smith, 1999).

The practice of Western science has been used to subjugate groups of people, deeming them primitive and less than human while at the same time appropriating their knowledge and culture, especially in the field of medicine, without giving credit. Moreover, Western Science operates around a set of values—values that influence one’s decisions on what topic to study, how to study the phenomenon, what framework one chooses to guide the analysis and interpret the findings, how one chooses to package and disseminate the knowledge (Bang et al., 2018). All these values reinforce the ethnocentric practices that “support claims of the colonizers cultural superiority” (Bang et al., 2018, p. 150). Framed
under a colonial guise, these standards, unintentional as it may be, still present barriers in creating equitable and socially-just curricula design and teaching practices in science education (Adams et al., 2008).

The colonial centres of Western Europe, as Quijano (2000) asserted, profited from the violent repression of the “the colonized forms of knowledge production” and this “epistemic suppression” gave rise to the colonial extraction and reproduction of domination (p. 541). The coloniality of power through knowledge is a long-standing violent reproduction in the culture of science. Historically, Black and Brown bodies have suffered in the name of scientific advancement.

The mistrust among the African American and Indigenous communities, women, and the poor stems from the social institutions of race, class and gender that provided the backdrop for the ethical malpractices (Wasserman et al., 2007). Examples of this suffering are evident in the Tuskegee Syphilis Study in the 1941 cases of treatment being withheld from African American men who were infected with syphilis and the African American women who were operated on without anaesthesia on by the gynaecologist, hailed the “father of gynaecology,” J. Marion Sims (Wasserman et al., 2007).

Another example is found in a staple required reading in many science classrooms in the USA: the famous story of Henrietta Lacks whose cells were being used in research without her family’s knowledge or consent (Skloot, 2011). The abuse and violence perpetrated against Black and Brown bodies were not only observed in the USA but were also seen in other Western countries as well. In Germany, for instance, mixed-race children, born out of intimate communications between French African soldiers and German women following the First World War, were forcibly sterilised (Dabiri, 2019).

These horrid examples from the not-so-distant past reveal the underbelly of scientific advancement that continues to have far-reaching implications in communities of colour in respect to scientific research and medicine. It is for these reasons that science education has to be approached from a critical perspective for the purpose of enacting a more socially just lens to disrupt racialised, gendered and classed ideologies.

Dutch background and context

Similar to other European countries, the contemporary Dutch population is becoming more diverse and multicultural compared with the past more homogenous Dutch society. The percentage of the Dutch population with a migrant background is now 24%, and it is projected to increase to 39% by the year 2060 (CBS 2019). There are four major migrant
groups in the Netherlands, with a 1-in-13 ratio of Dutch residents belonging to one of these groups (CBS, 2019). However, the population of each group is under 3%. The population breakdown includes Turkish migrants being at 2.4%, Moroccans at 2.3%, Surinamese at 2% and Dutch Caribbeans (Dutch citizens from Aruba, Curacao, Bonaire, Saint Martin, Saba, and Sint Eustatius) at 0.9% (CBS Jaarrapport Integratie, 2018).

We pause here to explain the complexities of the status of Caribbean Islands within the Kingdom of the Netherlands: Aruba, Curacao and Saint Martin are independent countries within the Kingdom; Bonaire, Saba and Sint Eustatius are special overseas municipalities of the Netherlands. Swells of migration, in the Netherlands, are tied to economics, the invisible colonial machinery that still keeps the former colonies tethered to the colonial power. The increased arrival of migrants from the former colonies of the Caribbean, that is, Suriname, Aruba, the former Dutch Antilles (Curacao, Bonaire, Saint Martin, Saba, and Sint Eustatius) and Indonesia, occurred in the aftermath and rebuilding of World War II (Essed, 1997). Later, migration of Surinamese, Arubans and Caribbeans of the former Dutch Antilles to the Imperial Kingdom rose with the economic downturn of the 1970s and 1980s (Essed, 1997). The presence of Moroccans and Turks is dated back to the 1960s when they emigrated to the Netherlands as migrant workers (Zorlu, 2012) during the post-World War II economic and subsequently migrant boom in northwestern Europe.

Similar to the immigration pull on the former colonies—a pull to rebuild the sites of colonial power—Moroccans and Turks were filling the gap in the market for unskilled labour shortages in agriculture, industry, mining and construction in the Netherlands (de Hass, 2007). The point of interest in this paper is that of migrant students, more primarily Dutch Caribbean students, and the opportunity gap (Welner & Carter, 2013) and the educational debt (Ladson-Billings, 2006, 2007, 2013) that has accrued through “social, cultural, economic and political” (Ladson-Billings, 2007, p. 8) negligence—the onus lies with the Kingdom, not the students and their families.

The opportunity gap, Welner and Carter (2013) assert, refers to the foundational disparities in society, communities and schools toward certain groups that are compounded to produce major differences in educational outcomes. Similarly, the educational debt, Gloria Ladson-Billings (2006) advances, is the deficiencies in the “historical, economic, sociopolitical and moral” (p. 5) policies and decisions that have accumulated over time. Consequently, these disparities in educational outcomes and life chances lead to significant differences in socio-economic, political, and social standing, and, in the case of science fields, the loss of skills, innovative ideas and creativity.
Regardless of their colonial ties and a seemingly higher likelihood of integration based on cultural similarity and access through language, Dutch Caribbean students are more likely to be tracked into the lowest secondary school track, earning a basic certificate upon graduation. This systemic iniquitous method of tracking leaves students of Dutch Caribbean and Turkish backgrounds disproportionately represented in higher numbers in the lowest of the three secondary tracks compared to their native Dutch counterparts (CBS Jaarreport Integratie, 2018).

The term “migrant background” refers to newcomers who emigrate to the Netherlands including displaced migrants seeking asylum and refuge or voluntary migrants. In this context, someone with a migrant background extends up to the fourth generation as it is based on at least one parent having been born outside the Netherlands or who has a migrant background. On the other hand, a Dutch native is considered as someone whose parents were born in the Netherlands.

This term, however, excludes those with fore parents born outside the Netherlands as in the case of the former colonies: Suriname, Aruba, Curacao, Bonaire, Saint Martin, Saba, and Sint Eustatius. This refers to the division in Dutch society of native versus migrant. The labels autochtoon (native) and allochtoon (non-native) are used to delineate between native and non-native origins (Weiner, 2014). Essentially, this means that a third-generation person of Dutch Caribbean descent, from Suriname, or the former Dutch Caribbean Antilles, is considered allochtoon (Weiner 2014).

This outsider/insider status bestowed upon peoples from previous Dutch colonies, from countries that are still within the Kingdom of the Netherlands subjugates them to the rung of perpetual Other in Dutch society (Wekker, 2016). Arguably, to be Othered means that there is a privileged insider and disadvantaged and excluded outsider (Bennett and Walker, 2018). As Philomena Essed, one of the most prominent among the few critical race scholars in the Netherlands, and Gabriele Schwab (2012) asserted that this otherness is linked to the positioning of students who do not fit white Western heteronormativity as outsiders; it is an attempt to reinforce white Western heteronormativity as cultural cloning. Cultural cloning is described as the process of replicating and enforcing cultural values, practices and ways of being that privileges one group while maligning the cultures of others (Essed & Schwab, 2012).

In the course of othering and cloning, students who do not fit the dominant narrative are excluded. This is a palpable experience for Dutch Caribbean students who emigrate to the Netherlands, the mother country, in order to advance their education only to be met with this
insider/outsider status, as evidenced by an Antillean young man’s account of his experience in Dutch higher education:

Through uncalled-for language corrections, ‘jokes’ based on racial stereotypes and prejudices I was and still am continuously reminded that despite my efforts to fit in, my access to the Netherlands is conditional...students from the Dutch Caribbean... say goodbye to the familiar without being entirely embraced by the new receiving society, which brings about the in-between, a third space of reality, also referred to as liminal space. (Leito, 2019, p. 180)

The in-between space that Karym Leito (2019) describes reinforces the cultural imaginaries (Wekker, 2016), albeit, racial and colonial imaginaries, where people from the former colonies of the empire are made to feel as “eternal foreigners” (Wekker, 2016, p. 10) in the Dutch empire. A paradox of sorts, to borrow from Gloria Wekker’s description of the Dutch Imperial past. A past that has been strategically erased from the everyday consciousness of Dutch citizens. The Dutch contemporary self-representation of the open, tolerant, and inclusive society is in conflict with the violent, slave-holding, and colonial past (Wekker, 2016). However, the presence of people from the former colonies of the East and West serves as a jarring reminder of this paradox in contemporary Dutch society.

**An overview of the Dutch schooling context**

Herein, laid out are descriptions of educational practices that reinforce systemic inequities that, on the surface seem supportive of students’ development, but, in actuality, they only serve to maintain the status quo, and consequently further marginalise and increase educational disparities between Dutch natives and, in this case, Dutch Caribbean students, in the Netherlands. On this basis, we advocate for addressing goals related to equitable and justice-oriented science education.

The Dutch education system is tracked into the three disparate groups that result in different educational secondary school diplomas, which follows a binary pathway into higher education (see Fig. 1) (Zorlu, 2013). There is the pre-secondary vocational track, the lowest track, a four-year program that leads to a vocational certificate, compared to the general secondary education five-year track that leads to a professional university degree at a university or an institution of applied sciences and the third and highest track, a six-year pre-university program that affords students entrance into one of the 13 Dutch research universities (Vedder, 2006).
The system of tracking limits students’ access to science-oriented professions. Fewer students of migrant background enter the highest track in secondary school that leads to admittance into higher degree-granting institutions to earn a professional diploma or research university. In achieving higher education degrees, students from Caribbean backgrounds, for example, tend to choose among the disciplines in law, humanities, and social sciences (CBS Annual Report Integration, 2018). This suggests that the likelihood of students from the Caribbean backgrounds of choosing and entering science-related fields is lower.

Therefore, one could surmise that Caribbean Dutch students are underrepresented in science courses and, ultimately, science careers. Here, lack of interest on the part of the student and low social and educational capital family background (Zorlu, 2013) might explain this phenomenon. However, a counterargument is that students of migrant backgrounds including Dutch Caribbean students are granted fewer opportunities to engage with and access schools that puts them on a path to scientific careers. Additionally, fewer students from migrant backgrounds enter the highest track in secondary school that leads to admittance into higher degree-granting institutions to earn a professional diploma or research university.

Some might argue that tracking provides students avenues to succeed in an
environment that is conducive to their needs and abilities. However, embedded within this argument, that is left unaddressed, in the case of the Netherlands, is its failure to take into account the implications of biases of low expectations, especially when these could be fraught with implicit ethnic, class and racial biases (Gilbert & Yerrick, 2001). Considering that Dutch Caribbean students, through their colonial ties, speak the language and have some intimacy with the Dutch culture should have more access to the social and cultural capital. However, the educational disparities between their Dutch native counterparts do not reflect this access. What we put forth, in this paper, is that the intricacies of being colonised within the land of the coloniser that remains, for the most part, unacknowledged and unaddressed in education push the group to the periphery and applies to their education. Gilbert and Yerrick (2001) found, in their study with students from underrepresented groups in a lower track science class in a rural city in the USA, that the students believed that they themselves were incapable of pursuing science. Additionally, their teacher had a low perception of their students’ abilities and thought the science too rigorous for them (Gilbert & Yerrick, 2001). Tracking deepens perceptions of deficit-oriented and attitudes of low expectation that supports discriminatory practices against Dutch Caribbean students and students of other migrant groups.

Stacking is another practice that, on the surface, is seemingly inclusive as it improves students’ chances of gaining access to higher education. On the contrary, stacking, a process that allows students to climb the certification ladder takes the student more years to obtain a degree. In this practice, a student must earn a basic qualification before moving on to the intermediate certificate to enter an applied science university, then earning a professional degree before moving onto a research institution to earn a master’s degree or higher (Leito, 2019). While this shows the student’s tenacity, it takes them more years to earn degrees from higher education institutions since students first earn a vocational certificate before earning a general secondary school diploma, before they can apply to an institution of applied science (CBS Jaarrapport Integratie, 2018).

It must be noted that only secondary students in the pre-university track are able to gain admittance to a university; otherwise, one has to go through the stacking process outlined earlier. Comparatively, a student who enters the middle or higher track of secondary school circumvents this process of stacking by advancing straight into a professional degree-granting institution of applied sciences or a research university.

Compounded by the inherent biases in tracking and stacking practices, students from Caribbean backgrounds are less likely to study a natural science degree, as they are hampered
by an educational system that limits their access. As discussed earlier, compared to their Dutch native counterparts, fewer students of migrant background gain admittance into the highest track that provides a gateway into universities where scientific research is undertaken (Netherlands Ministry of education, Culture and Science, 2020). On the whole, this trend lessens the likelihood of a student from a Caribbean background pursuing a career in science. For instance, the Netherlands Centraal Bureau voor de Statistiek Statistics (CBS) 2019 annual report indicated that 21% of Turkish and 22% of Dutch Caribbean students are in the lowest track in which they earn a vocational degree upon matriculation. This percentage is countered with the paltry 8% of the Turkish and 12% of the Dutch Caribbean student population in the highest track in research universities.

The Netherlands is used in this paper as an example of a country with a colonial past, in order to make the case for the urgency and value of addressing goals related to social justice in education. This interest is rooted within the fact that the community of educational researchers, especially in the area of STEM education, have remained largely uninvolved with research that examines issues related to access, inequality, colonization and equity.

As Wekker (2016) argued in her book, White Innocence: Paradoxes of colonialism and race, unlike North American academics, Dutch historians have persistently abstained from seeking colonial connections. Educational research in the Netherlands, we maintain, has also abstained from seeking colonial connections and examining how those shaped the curriculum. Instead, research efforts have focused solely on students’ interest, concept learning and skills development as well as the professionalisation of teachers for teaching science and technology (e.g., Akkerman et al., 2019; Jansen et al., 2019; van der Wal et al., 2019; Vennix et al., 2018).

Our purpose in this paper is not to offer an exhaustive overview of the research done in the context of the Netherlands, but simply to highlight the fact that some issues remain unspeakable, and some questions remain unexplored. This is precisely where the contribution of this paper is found in that it calls for a thorough engagement with issues related to race and classroom-inequalities in the Netherlands, especially in the context of STEM education. Beyond this call, we also provide a concrete example of the design of a community- based STEAM program framed within culturally relevant/responsive and sustaining pedagogies (CR-SP) and targeting young children with a migrant background. Critical theory

Critical theory is a transdisciplinary field that has application to various fields of study, especially in the social sciences. It is also advanced as a framework in educational
practice research. The goal of critical theory is to critique, theorise and undo the structure of oppression such as white supremacy that affects all areas of life, with education being of no exception (Pirbhai-Illich et al., 2017).

Critical theory also underpins feminist theory, critical pedagogy, and critical race theories with its offshoots of Black Crit, LatCrit, Asian-Crit, QueerCrit, Tribal Crit and even critiques of whiteness, all having applications to the field of education (Dumas & Ross, 2016). Critical race theory was developed in the legal field with legal scholars such as Derrick Bell, Kimberlé Crenshaw, Richard Delgado, Mari Matsuda, and Patricia Williams at the helm (Delgado & Stefancie, 2017, p. XV). Gloria Ladson-Billings and William Tate introduced critical race theory to the field of education with a strong focus on anti-Blackness in education (Dumas & Ross, 2016).

Ladson-Billings, herself, coined the term culturally relevant pedagogy in response to the way African American students were being taught in integrated US schools by mostly white middle-class teachers (Ladson-Billings, 1995). Critical race theory has been used to destabilise the dominant discourse and colonising practices that have perpetuated hegemonic “subordination of gender, class, and sexual orientation” and the persistence of racial inequities and racism (Solorzano & Yosso, 2001, p. 472). The transdisciplinary foundation of critical theory, a theory of critique, makes it applicable to the field of science education. Critical theory affords a decolonizing construct to examine the hegemony of science education.

In this paper, we propose an overarching application of critical theory to frame educational research for the purpose of decolonizing science education and cultivating a socially just society in settler colonial and former colonial contexts, such as the Netherlands. The theory includes theoretical constructs that seek to dismantle the hegemonic discourse of the dominant in science education, to challenge the status quo and to address classroom inequalities that are inextricably bound in colonialism and elitism.

Culturally responsive education: to whose culture are we responding?

Some may say education has always been culturally responsive. This statement begs the question: To whose culture are we being responsive? (Yosso, 2006). A few researchers have engaged with this question by problematizing elitist approaches to culture, education, and science through the concept of “whiteness.” Bobby Habig, Preeti Gupta, Brian Levine, and Jennifer Adams (2018) bring up this point when they describe how whiteness shapes diversity initiatives in informal science learning. In the US and European contexts, whiteness has been generally defined as a set of characteristics and experiences that are attached to the
White race, which marks one as normal and native, while people belonging in other racial categories are perceived as “foreign” (Wynter, 2003).

Whiteness has been the centre of education and curriculum, and science education is no different. To examine science education, we have to examine whiteness and Eurocentrism as the dominant constructs at play given that in society, everyone is an actor enacting implicit or explicit roles based on their perceived positioning by themselves and others. Consider, for example, the role of the person receiving the action: the passive recipient of an action means there has to be a subject orchestrating that action. Thus, to be part of a group that is being marginalised then there has to be a group that is manoeuvring that state of being. The marginalise relegates the positioning of the marginalised (Cabrera et al., 2016). Critical Whiteness race scholars seek to analyse whiteness as a construct and ethnic group, going beyond the good/bad binary to unearth how whiteness as power and material property permeates all levels of society (Cabrera et al., 2016).

The word “culture” also signifies othering in education. The inclusion of cultures means there is an exclusion from acceptable forms of knowledge. The mere sprinkling of other thoughts of being in response to inclusion suggests that there is a dominant culture that still relegates what acceptable sources of knowledge in different disciplines are.

**Historical overview of asset-based pedagogies**

The call for a multicultural approach to education surfaced in the late 1960s in the USA—the period following the landmark legislation of *Brown vs. Board of Education of Topeka* 1954, the Little Rock nine (African American students integrating an all-white school), and within the era of the Civil Rights Movement. African American children were not getting a quality education even within well-resourced schools. Multicultural education emerged in the late 1960s as a countermeasure to the American school system that upheld middle-class Eurocentric values (Ladson-Billings, 1994).

The approach to teaching upheld the dominant culture of knowledge while making inferior the knowledge of the non-dominant. The education reform efforts championed the practice of explaining the teaching about African American culture, achievements, and history. There have been countless stances on the need for education of learning and teaching to respond to the culture of the people of colour in education following the 1960s into the successive decades.

Gloria Ladson-Billings used the term *culturally relevant pedagogy* (CRP) in her book, *The Dreamkeepers*. At its core is the concept of teaching and practice that honour and
centre African American students’ culture, values and norms in the classroom or school, especially students living in poor communities crippled by federal, state, and local instituted dis-enfranchisement. In the USA, *culturally relevant teaching* emerged as a pedagogical stance to teaching African American students and other minoritised groups (Native peoples, Asian, Latinx, African diaspora, Brown) in the early 1990s. It has since been adopted and used by researchers in other contexts as well.

Gloria Ladson-Billings’ vision of culturally relevant pedagogy is one that incorporates the family’s and community’s presence into the curriculum and school building; incites love of oneself, family, and community; equip students to challenge the ideology that minoritised their culture, family, community, and ways of being and empower children to strive for excellence in every area of their lives. Culturally relevant pedagogy also extends to families—to empower families to demand the best for their children from the school board, trustees, local and state government. The major tenets of culturally relevant pedagogy/teaching (Ladson-Billings, 1995, 2009) are the following: academic success learning; sociopolitical consciousness; and cultural competence.

The definition of culture used in culturally relevant pedagogy formulated by anthropologists and sociolinguists is “the complex of explicit and tacit factors-knowledge, customs, arts, aesthetics, beliefs, language, symbols, and so on—that members of a community share and are made and remade with each generation” (Cazden & Leggett, 1976, p. 4). Rooted in Afrocentric Feminist theory, Critical Race Theory and Critical Race Feminism, CRP deviates from positioning African American students and other students of colour as “deficient.” What Ladson-Billings (1995) terms succeed in doing is to address deficient pathology of assimilationist teaching, which views the education of “poor African Ameri-cans” as a means of accessing the dominant culture: white middle-class cultural norms. A culture that is seen as the truth, the one to aspire, and rendering all other cultures inferior.

**Culturally responsive teaching**

Geneva Gay (2002) uses culturally responsive teaching to help teachers and teacher preparation programs “respond” to the demands of multicultural education. To create a class-room atmosphere that accommodates culturally responsive teaching, teachers need to prepare curriculum using their own cultural experiences first as a scaffold and then, actively seek to widen their knowledge of their students’ ethnic and cultural diversity (Geneva, 2002). With this broadened knowledge base, teachers can design curriculum and procedures that are culturally responsive (Gay, 2002). Geneva Gay (2013) contends that the word *culture* in
culturally responsive teaching is synonymous to “values, attitudes, and beliefs; customs and traditions; heritages and contributions; and experiences and perspectives” (p. 52) of ethnically, racially, and culturally diverse students. There are four components of culturally responsive teaching that the educational researcher advocates. The first component is that teachers should adjust their attitudes and beliefs about students and communities of colour. Teachers should actively work to replace pathological and deficient views of students and their communities with positive ones.

Secondly, teachers should be prepared to know that there are oppositions and resistance to culturally responsive teaching. Knowing these beforehand, teachers are prepared and are able to recognise avoid or confront these differing views without distracting the work of offering culturally responsive curriculum and instruction. To this end, the third component, culturally responsive teaching should centre the importance of cultural diversity in education. Finally, teachers’ curricula should reflect the local and context settings of the students (Gay, 2013).

The terms culturally responsive and culturally relevant have been used in the education literature since the 1970s in American schools and since Courtney Cazden and Ellen Leggett (1976) response to the US Supreme court’s decision in the 1974 case of Lau v. Nichols. The court ruled that it was unlawful under the Civil Rights Act of 1964 for San Francisco schools to deny support for Chinese American students whose first language was not English in the form of bilingual education schools. Cazden and Leggett (1976) made a case for providing and equipping teachers to address bilingual and bicultural education in schools.

The terms culturally responsive and relevant, in this case, were conjoined to mean the teachers’ efforts in incorporating cultural practices of the non-dominant group in the lesson. As Courtney Cazden and Ellen Leggett (1981) argued: “Culturally responsive education rests on the fundamental nature of culture and the nature of intelligence” (p. 32). Hence, in order to respond to the “invisible” culture, schools should pay attention to the interactional styles of students and incorporate members of the community in the day-to-day operation of the school and classroom structure.

However, in present society, this recommendation reinforces stereotypes as the low skill jobs in schools and classrooms are mostly occupied by individuals who do not identify with the dominant culture. There have been other pedagogical approaches that have sought to prescribe the use of the culture of the other in classroom teaching and learning practices: “culturally appropriate” (Au, 1980); culturally congruent (Mohatt & Erikson, 1981);

**Culturally sustaining pedagogy**

Paris and Alim (2014) saw a multilingual practice or as Alim writes, “multilingual fluidity,” emerging from their research with students at a California high school. Students used a multitude of other languages than their own to communicate with each other. This is an example of multilingualism influenced by Hip-Hop culture and African American Language, without forsaking their cultures and languages (Paris & Alim 2014). Paris and Alim (2014) posit that educators must be explicit in their stance to sustain “languages and cultures in [educational] pedagogies in both the traditional and evolving ways they are lived and used by young people” (p. 91).

CSP adds to students’ (existing) body of knowledge not to try to take away from and demean their ways of being that they encounter and enact with their families and friends and in their homes and communities. McCarty and Lee (2014) extended the work of CSP to incorporate a revitalisation of the language and culture, that is, culturally sustaining/revitalising pedagogy, a reclamation of the language when working with Indigenous youth. As they argued, in order to gain Indigenous education sovereignty, there has to be a concerted effort to reclaim the language and culture that have been stripped away from the people in the “ongoing legacies of colonization, ethnocide, and linguicide” (p. 105).

One approach to applying the synergistic effect of culturally responsive–sustaining pedagogies is to create a space for the co-construction of knowledge where students’ choices and direction are central. How can this be achieved? A review of related literature shows that one such approach is through projects that allow students to choose what is contextually and culturally relevant to their local settings but not limited to the borders of their communities, town, or country. In the next section, we offer a description of a community-based program in the Netherlands that is designed upon the tenets of CR-SP for the purpose of supporting young children’s development of a sense of agency.

**Curriculum implications: ROOTS: “Ik ben science!”**

ROOTS: “Ik ben Science!” (I am science) is a research-based, STEAM enrichment, community-based program that draws on disciplines in science, technology, the arts, the environment, engineering, and mathematics. ROOTS is used to refer to the call for environmental sustainability beyond geographic boundaries. “I am Science” is used to refer to students’ self-identification with science. In each session, the students are engaged in science investigations rooted within authentic problems situated in their homes and the local
community, for example, testing air and water quality.

There are 25 families enrolled in the program with children ranging from 6 to 12 years old. The program is open to all children; however, the research associated with it is carried out with Dutch AfroCaribbean children. Families chose to attend on their own accord and not based on teacher or school recommendation, which we are hoping that is has eliminated the risk of further tracking of bias of who belongs in science and who does not (Avraamidou & Schwartz, 2021).

The composition of families who attend cut across the socioeconomic ladder, migrant and cultural: from a single-parent student, poet, and yoga teacher to a clinician who owns her own clinic. As part of ROOTS, the families get together every Saturday morning at the community centre. Between the children, parents, volunteers and instructors, there are 35 people in a space which doubles as a meeting room for the staff and classroom for workshops and programs including ours.

The facilitators, mostly volunteers, are a diverse group of undergraduate and graduate students as well as scientists from the alpha and beta sciences: physics, geosciences, science communication, physiology, pharmacology, and psychology. Although the program is exclusively bilingual—Dutch and English—it is a multilingual reservoir of languages spoken in the group: Papiamento, Spanish, Hindi, Greek, Frisian, Afrikaanse, Zulu, siSwati, Tswana, French and German, just to name a few. The multiple languages spoken as a collective are a testament of the ethnic and cultural diversity within the group.

The site for the program is at a youth community centre that serves the community in a neighbourhood situated in the northern province of the Netherlands. In comparison with other districts in the urban centre of the province, it is regarded as a working class and a more multicultural neighbourhood in a municipality that is considered one of the poorer cities in a province that is deemed among the poorest in the country (van der Kaaden, 2017).

The centre provides social programs and activities for its mostly working-class clientele, one of which includes a free breakfast program for the children who attend activities at the centre. Breakfast, a testament of the economic challenges some families face, is offered as some are not able to afford this for their children (Coordinator of the centre, personal communication, January 28, 2020). The families who attend ROOTS come from the district as well as the neighbouring districts.

While a detailed description of the research component of the program is beyond the scope of this paper, in what follows we briefly discuss the research goals in order to provide a basis for understanding the rationale for the curriculum design which follows. The research
component of the program is associated with the goal of employing the culturally adaptive pedagogies of responsive-sustaining pedagogies in science education, as means for supporting young children develop disruptive science identities and consequently addressing the glaring inequalities in science education in the Netherlands.

Offering this program in primary education is most crucial because it is at the end of primary education that students are funnelled into the three educational tracks in secondary education. As a matter of fact, there is substantial research that indicates early intervention science education in the middle and primary grades that provide students with science experiences is crucial in sustaining students’ science identification and aspirations (Kim, 2018). This evidence offers justification for the target age group of children who participate in the program.

The choice of an after-school community program resonates within theories of learning and empirical evidence pointing to the fact that such spaces, unlike classrooms, provide motivating structures which have the potential to disrupt power dynamics and hierarchical relationships usually produced between students from the dominant and minoritised groups (Avraamidou & Roth, 2016).

The goal of the program

The goal of the program is to offer a space for children and their families to come together to interrogate socio-scientific issues in their communities that they can respond with a call to action. In doing so, the program aims to create and as well as invite experiences of the families that attend, the scientists who come in to share their life histories and the volunteers who share their expertise each week.

The curriculum was designed with the input from a member of the Dutch Caribbean community who was also involved in helping to recruit families and volunteered in the sessions on Saturday mornings. The community member, Ma Troela (pseudonym) is of an older generation who has done extensive local advocacy work on behalf of the community and who had also previously run an afterschool program at another community centre in the neighbourhood. The first author, who shared a similar transnational identity of being born and raised in the Caribbean, then emigrating and living in the USA and the Netherlands, met with her on a biweekly basis for five months the year prior to the start of the program. They continued over emails and text messages.

The initial meetings served as brainstorming sessions about the design of the curriculum. For example, we brainstormed lessons that included the performing and visual
arts, storytelling and environmentally conscious: what we saw as culturally affirming ways of the Caribbean identity. In addition to curricular work, we would discuss political, economic, and social challenges that the Caribbean community is facing in the north and the present efforts to maintain connection with cultural aspects that are distinctly Caribbean, for example, hosting events at various community centres and the junior carnival, that used to be hosted in the neighbouring hood “back in the day.”

Another point of input for the curricular design was assessment interviews with parents; Ma Troela was also instrumental in helping to recruit parents for the interview. A 30-min assessment interview administered to AfroCaribbean parents six months prior to starting the program. These brief interviews were conducted to gauge the parents and the likelihood of their children’s interest in attending. In addition to their interests, we also sought to find out they would like to see in such a program. Subsequently, following the first five weeks of the program, we did another brief interview, an informal assessment, with the families in the program including the children to assess how they found the program and what they would like to see in activities moving forward.

The program builds on the community with parents, instructors, volunteers gathering each week to embark on an activity together. Everyone was engaged—evidenced by their fervour in completing tasks, asking, and answering questions, following instructions, video-making and photographs documenting how they see science in their daily lives. Additionally, they are learning together as they build, design, and problem-solve ways to improve or test their designs.

The community goes beyond the curriculum in the act of coming together to reflect on the happenings of each week and what the children, instructors and volunteers are anticipating for the weekend. This is achieved through the simple act of gathering together in a circle with the purpose in mind of cultivating a sense of trust and belonging.

We want to encourage this sense of belonging, especially, to promote a collective consciousness that we are here to learn about and from each other. This is especially important in science engagement framed in CR-SP. To do that, we begin each session with a circle to reflect on our week and what we are looking forward to for the coming week. The circle process is borrowed from Kay Pranis’ (2004) restorative practices that create an environment that encourages care for each other as we pursue knowledge. Restorative practices within the restorative justice framework promote engagement and belonging in the community. The use of the circle process underpins the foundation of CR-SP: to weave together a cultural mosaic of collective belonging for all the participants in the program.
We argue for the involvement of family members as key players in supporting children in authoring their science identity. The family unit is crucial in communities that have been minoritised as extended and fictive kinships become a source of support (Alexakos, 2011). In the Black community especially, this hearkens back to traditions that were born out of a survival mechanism during enslavement but also ties to the Indigenous communities in their African homeland where the village is a central focus in helping to raise the child. This is also salient in other Indigenous peoples’ communities where the concept of the family extends beyond the immediate generations in the household like it is in Westernised society (Chatters et al., 1994).

Culturally adaptive pedagogies are incorporated into the design of the program’s curriculum. For example, one of the units focuses on a lesson on earthquakes. Though on its own a unit on earthquakes might not seem aligned with the culturally adaptive pedagogies of CR-SP; it is, however, contextually relevant to the children’s and their families’ lives. One of the tenets of CRP along with high academic success and cultural competence is socio-political consciousness: This lesson engages children with questions about the socio-environmental impact of natural gas extraction on their and neighbouring communities. Children being awakened in the middle of the night or fear of their homes being destroyed and families relocating due to earthquake tremors from natural gas extraction—an exploitation that does not directly economically benefit the northern residents—is a socio-political issue and is part of the geopolitical landscape shaping these children’s lives. Culturally adaptive pedagogies not only connect to children’s experiences but also connect these lived realities to the broader contexts (Patchen & Cox-Petersen, 2007).

The following excerpt is from Een veilig huis, een veilig thuis (2019) a report on the impact of the gas extraction on the children living in the province—the same area where the families attending program live. In the excerpt, a 12-year-old child shares with the interviewer their lack of proper rest from fear of their house collapsing while they are in a deep sleep:

Wat, ik heb zelf altijd, uhm, heb ik steeds minder diepe slaap. Ik sliep eerst altijd heel diep en daar was ik bang voor. En ik heb steeds een minder diepe slaap en uhm, dat zeg, dan denk ik van, als het trilt dan voel ik het wel. Ja dan kan ik gewoon iedereen wakker maken. Dan kunnen we naar buiten of zo. Dan kunnen we weg.

What, I always have, uhm, I have less and less deep sleep. I always slept at first very deep and I was afraid of that. And I keep having a less deep sleep and uhm, say that, then I think, if it vibrates then I can feel it. Yes, then I can just wake everyone up.
Then we can go outside or something. Then we can go.

(Zijlstra Zijlstra et al., 2019, p. 5)

The occurrence of earthquakes in the northern provinces and areas close to where the program is situated, in a country which geographically should not experience this phenomenon, are quite prevalent and has far-reaching social and ecological impact on the population (Melanie et al. 2018). The continuous exploitation of this natural resource leaves the already vulnerable residents in a pernicious cycle as the earthquakes damage infrastructure including private homes, leaving frustrated homeowners to deal with damages and the cumbersome reporting system (Postmes et al., 2020).

The five-part-lesson unit features the questions of what, why and how: (a) What is happening? (b) Why is it happening? (c) Who is benefitting from this venture? (d) What are the social and environmental implications of such acts? (e) Can it be prevented? and (f) What actions do we need to take to alleviate the situation? The unit has been developed by a diverse group of women with different interests and experiences.

The interdisciplinary team includes a Dutch social scientist, a South African Environmental and Infrastructure planner, an AfroCaribbean educator and biracial Bolivian and Dutch of Indigenous heritage documentarian/activist whose work centres Indigenous communities and collective activism around environmental injustices. In both the first and second lessons, the children explored what earthquakes are, what causes them and why we experience earthquakes in the north; lastly made a model of sandstone geology layers of the decompressed and gas extraction. In the third lesson, they discussed ways they have experienced earthquakes and watched a brief documentary (CODE ROOD, 2018) directed by the Dutch Bolivian documentarian on the history of gas extraction and earthquakes in the area.

They also read Een veilig huis, een veilig thuis? (2019), a booklet—as part of a larger report—intended for a young audience, compiled of drawings and stories of young children and teenagers, who like them live in the north, documenting their experiences with the psychological and physical effects of the earthquakes. In the fourth lesson the children performed a song and dance on the impact of gas extraction on the community choreographed by an AfroCuban music and dance teacher.

In the fifth and last lesson, the children were introduced to the work of the documentarian and activist, as well as learned how to write a script and tips on making their own videos. On their own, the children developed the script and prepared videos that served as public service announcements to build awareness about the earthquakes that are happening
in their province. Examples of the final products the children made range from an investigative exploration to the damage of homes in their neighbourhood, a simulation of tremors caused by earthquakes, to a demonstration of safety precautions during earthquakes. Their videos were presented on the last day of the program with families and friends.

Another example of CR-SP in action, in addition to children’s agency, is conducting Do-it-Yourself science investigations from Smart Kids Lab (http://smartkidslab.nl/). Some experiments were environmentally-based with an investigation of the pollution level of the water in the dams in their neighbourhood, science in the kitchen, noise pollution in the neighbourhood. A culturally affirming way the children were taught to deliver their experiments results is through storytelling. The children were introduced to storytelling by a Kenyan-born storyteller who uses African folktales (African Folktales Project) to tell stories about science. The storyteller narrated a story entitled “The First Rainbow.” The story was about a young girl who was curious about how rainbows are formed and went about her day in wonderment at seeing different colours of the rainbow in elements of her day-to-day activity. In the story, her aunt shared the story of the first rainbow, which is an African folktale:

There was a little boy called Toto, who brought the colours of the rainbow to the land of Tonota. For a long time, people in Tonota only knew the green of the plants and the brown of the soil. But Toto had vivid dreams of clouds in glorious colors! He told Mzee, the elder, about his dreams, and he said, ‘If you can name the colors, I can bring them to life.’ Then Mzee called all the rainmakers across the land, and they joined hands and formed a circle, waiting for Toto to name the colors. Toto began paying attention to his dreams. Then one by one, the colors appeared brightly. ‘Red, Blue, Orange, Yellow, Purple, Green, and Indigo!’ Toto named them all. The colorful clouds filled the sky and formed the shape of an arc! Everyone cheered and rejoiced. This was Tonota’s first rainbow. Then, Toto looked carefully at the arc of colors, and at the end of the rainbow, he noticed a pot. It was filled with gold! And since then, only Toto has seen the pot of gold at the end of the rainbow, said Aunty.

(W. Hoffman, personal communication, November 21, 2020)

The author then shared tips on how the children can write their own stories and best strategies on how to present them. Not only was the lesson affirming of the culture of Africans and people of African descent—AfroCaribbean, but it also affirmed the ancestral stories and featured cultural aspects of community in illustrating the foods we eat like mangoes and fried chicken, and the extended family systems characteristic of people of
African descent, e.g., the aunt was the main authority figure in the story, not the parents.

Table 2 outlines how the theme of each unit reflects the tenets of the culturally responsive-sustaining pedagogies.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Learning Goals</th>
<th>Activities</th>
<th>CR-SP tenets/design dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physics and engineering</strong></td>
<td>Through the activities provided, the children will engage in activities around renewable energy and engineering concepts. Each activity is a design investigation where they will explore how they can change variables in the mini-project to see how they impact their measurable variable, including robotics and building a microphone with material physicists.</td>
<td>In the north of the Netherlands the children might see different forms of renewable energy being used. For example, we construct and compare the speed of the hovercrafts on different surfaces. The students will explore the force of friction caused by different surfaces. The following week we design and build wind turbines and follow by using solar power to power their insects made from renewable materials.</td>
<td>CR-SP includes the topics that are relevant to the children’s lives.</td>
</tr>
<tr>
<td><strong>Arts and Science</strong></td>
<td>Arts and Science Through the incorporation of the arts, the children will explore different environmental themes using theatrical improvisation and dancing. The children can also use the computer programming Scratch to create their animations.</td>
<td>The activities incorporate performing and visual arts.</td>
<td>CR-SP fosters a sense of belonging that includes not only the content but an interdisciplinary approach to the sciences that incorporate the traditions of a more communal society. For example, the movement and arts that are often seen as separate from the sciences are included in a science program.</td>
</tr>
<tr>
<td><strong>The Environment</strong></td>
<td>Six-part lessons centred around the earthquakes happening in the north as a result of gas extraction. Why is it happening? Who is benefitting from</td>
<td>Activities about earthquakes (e.g., the role of plate boundaries, seismic waves, measurements. All about earthquakes in Groningen and in the home.</td>
<td>Recognizing the political and environmental impact of the earthquakes happening in their...</td>
</tr>
</tbody>
</table>
this venture? What are the social and environmental implications of such acts? Can it be prevented? What actions do we need to take to alleviate the situation?
countries of the parent generations Social and Environmental Impact Build Awareness. Creating Public Service Announcements around the issue.
province is crucial to their experiences. CR-SP as a practice encourages the inclusion of critical awareness of what is happening in the children’s environment.

| Personal Design Investigations | Children develop their own investigations. From these investigations, they will create presentations on their results for their families and friends. | Create a space for the co-construction and co-creation of the issues students want to investigate in their neighbourhood. These are contextual and relevant to their lives, and they are the ones who would know what and how they want to address these issues. | CR-SP emphasises the need to have students tap into their creativity and resources to innovate ways of addressing issues that they encounter in their immediate and regional contexts. |

**Conclusion**

A range of frameworks have been utilised in the last two decades to conceptualise issues of globalization and multiculturalism: critical theory, feminist theory, post-structuralism, and postcolonial theory (Zembylas & Avraamidou 2008). Postcolonialism especially has offered a useful lens and created unique opportunities for science educators to gain a richer understanding of globalisation and multiculturalism by challenging reform efforts and science education pedagogies. This is precisely, as we argued in this paper, where the contribution of CR-SP can be found: it offers a constructive framework that problematises various aspects of the current social and cultural conditions of science teaching and learning and it promises to make meaningful and transformative changes to science education that promote goals related to diversity, inclusion, and social justice.

Our purpose, in this paper, was to explore conceptual links between asset-based pedagogies: culturally relevant, responsive, and sustaining pedagogies. Essentially, what we aimed to do was to examine how these conceptual frameworks might be implemented in practice for the design and enactment of curriculum materials in the context of a former colony. Our purpose was not to dig deep into the country’s colonial past and how that has
dominated the curriculum and educational policies. Instead, our purpose was to provide a concrete example of a specially designed, community-based, after-school, STEAM enrichment program for ethnically-minoritised children: to offer “an image of the possible.”

As described earlier, the program incorporates culturally adaptive pedagogies for the purpose of improving learning opportunities and tools for all children to make sense of the world they live in. A crucial point to note is that enacting CR-SP into an out-of-school science engagement, as it is the case for classroom science, presents challenges for all stakeholders: curriculum designer/instructor, facilitators, tutors, and families. As we trouble existing paradigm, we acknowledge that there are tensions in adopting what is CR-SP for the children and their families. In our case, even with two of the authors who identify as Anglophone AfroCaribbean, we realise that with the hybridised and diasporic identities of being Dutch AfroCaribbeans, we have to constantly mind the existing challenge of not overreaching and imposing what we think is considered relevant to the children in the program.

Another side to this discussion is associated with the challenges that science educators face when implementing CR-SP into the curricular design for out-of-school science programs. One of the main challenges is the theory-to-practice component of research focused on CR-SP (Brown et al., 2019). What Megan Bang and Douglas Medin (2010) cautioned a decade ago still holds true today: “Developing culturally-based science curricula is far from straightforward” (p. 1015). That being so, the question raised is one of how do informal science educators move from the realm of theory to offering CR-SP-enriched curricula in their programs?

The overriding truth, as they urged, is to address the “core problems of culture in science and science education and recognise the embedding of culture in everyday science practices” as the way forward. Roots: “Ik ben Science!” as a model brought to the fore considerations for other science educators to think about ways to engage families’ involvement and have a fully integrated CR-SP-enriched out-of-school STEAM program. Despite these tensions, it is of utmost importance that we are consistently moving toward incorporating culturally adaptive pedagogies into our curricular design.

Science education that champions science for all without examining, challenging, and dismantling long-held practices of colonial projects, forever locks itself into a system of inequality. The call for curricula development and educational policies in science education to adopt more culturally adaptive models strikes at the root of the problem instead of treating the symptoms. This is precisely what ROOTS aims to do through engaging children
and their parents in investigations about socio-scientific issues that are directly relevant to their everyday lives, as for example, the social impact of earthquakes. Hence, the activities serve as a means for engaging students in reasoning about data and sense-making as well as a means for including and embracing students’ diverse ways of reasoning and appropriating scientific vocabulary. At the same time, the activities invite students to bring in their histories, diversities, and stories as a means for embracing their roots, cultural values, and family capital.

Given the rapidly increasing ethnic, cultural, and linguistic diversity in the world, we urge science education researchers to consider goals related to supporting non-dominant students to engage with science in authentic and culturally relevant ways for the purpose of supporting them in not only seeing themselves as science persons but in also seeing themselves as agents of change. ROOTS provides a concrete example of a program that addresses such goals. We hope that this paper will provide the basis for conversations among educators and researchers interested in designing, enacting, and researching CR-SP-informed programs and curricula that aim to support students who have traditionally been marginalised and excluded from science in positioning themselves as insiders into the practice of science.
Chapter 4: Occupying spaces of liminality and hybridity: Exploring a Caribbean Dutch girl’s positioning and identity in a community-based Science programme

Abstract

In this study, we examine how the macrostructures of Caribbean diasporic identity and science identity relate to the mesostructures of a community-based science programme, thereby exploring the relationship between the macro-, meso- and micro-structures. In particular, we investigate how these relationships are played out at the micro level to inform a Caribbean Dutch girl's science identity authoring. Through an ethnographic case study, we used event-oriented inquiry to explore video and interview data. Our qualitative analysis of interviews and video data revealed that community-based programmes offered hybrid zones that link the ecological learning systems, e.g., the school and home, with informal science education spaces. The analysis indicates that her perception of science fuels the tension in her science identity authoring, a tension juxtaposed with the tension in her positional identity. The implications of this study underscore the value of emotions and resilience in science identity and family engagement in informal science education research and also the value of the richness of data that using video analysis provides.

**Keywords**: Science identity authoring, Diasporic identities, Informal science education, Liminality, Hybridity
Who are you?

Who am I?

I am...


The agentic and philosophical proclamation I am is central to identity studies. With its origins across several disciplines, the construct of identity has a growing niche within science education that focuses on science identity with a tradition of close to 30 years (Varelas, 2012; Shanahan, 2014). This paper follows the conventions of science identity grounded in cultural and social frames as acts of negotiation, positioning, and authoring.

Employing a bricolage of frameworks, we draw on the overarching sociocultural lens of Figured Worlds (Holland et al., 1998) to study science identity as framed within Identity Resources (Nasir & Cooks, 2009) encased in a Caribbean Diasporic narrative. We use these perspectives to investigate the ways in which science is enacted in a community-based science programme. In the following sections of this chapter, we outline each of these frameworks and how they overlap and intersect with science identity authoring.

We acknowledge that this investigation is conducted from the vantage point of our contextual positioning and knowledge. The opening poem illustrates the multiple identities of the first author, how she is positioned and how she situates herself in different frames and contexts. As the lead author, her positioning is critical to understanding the standpoint that guides the development of this chapter.

This research highlights the complexities and contradictions in the story of a 12-year-old named Red, who is of Dutch Caribbean descent, relative to her science identity authoring in a community-based science enrichment programme, Community Roots, situated in the Netherlands.1 By doing so, we seek to add to the knowledge base in informal science education to learn more about how young girls, especially those outside the dominant group, view and participate in science. Furthermore, we explore how spaces like Community Roots

1 With the exception of the authors, all names used are pseudonyms.
offer the resources for young girls from diasporic backgrounds to build resilience and foster emotions as bricoleurs in their own science identity authoring (Adams, 2020), in this case, a girl from the Caribbean Diaspora in the Netherlands.

A Note on Bricolage

The term *bricoleur* can be described as a handyperson who uses the resources available in their environment to fulfil a task (Kincheloe, 2011). The researchers in this study can be characterised as bricoleurs as we try to present the complexities and contradictions within Red’s narrative by layering various theoretical frameworks and methodologies to situate, make meaning and produce knowledge (Kincheloe, 2011). Employing a bricolage of theoretical and methodological approaches in research design allows us to untangle, deconstruct and interpret what is happening in the data and make meaning of what we ‘see’.

Critical theorist Joe Kincheloe (2011) asserted that "bricolage is concerned not only with multiple methods of inquiry but with diverse theoretical and philosophical notions of the various elements encountered in the research act" (p. 180). Learning from differences paves the way in supporting an “emergent and contingent research design” (Tobin, 2015, p. 3) in bricolage. We have relied heavily on the application of emergence and contingency in allowing the data to guide our theorising and analysis. Similar to a horse’s blinders, a single perspective limits the scope of how much a researcher can glean from their data, reducing complexity and narrowing what can be learned. Therefore, bricolage allows us to open up the collected data for deeper understanding and richer interpretation. Tobin (2008, 2016, 2016a) has persistently emphasised the importance of using bricolage, or what he terms multi-logical/multimethod bricolage, in drawing on multiple sources of knowledge to design, analyse and theorise our research.

Theoretical Grounding

In extending the analysis and theoretical framing of science identity, we use Figured World to marry the concepts of Identity Resources and Caribbean Diasporic Identity in examining the ethnographic case study adopted in this chapter. This extension of the science identity construct mirrors the development of critical theories born out of a need to open up and build on approaches to capture deeper analyses of race, gender, class, and other systems of oppression. For example, Black Feminism arose from the need to tell the stories of Black women and women from the global south (Combahee River Collective, 1974). Patricia Hill Collins, in her seminal book, *Black Feminist Thought* (1991), told the tales of Black women
whose stories were mainly excluded from the discussion in mainstream Feminism. Likewise, Kimberlé Crenshaw's famous work (1989) expanded on intersectionality to include the exclusion of intersecting paradigms of race, gender and class when talking about Black women.

Afrofeminists in Europe also brought to the discussion how their stories were similar to and differed from North American Black Feminist theorists (Akguwo, 2019). Similarly, Saran Stewart (2019) drew on the pioneering works of Kimberlé Crenshaw's (1989) Intersectionality and Patricia Hill Collins’ (1991) Black Feminist Thought in framing and theorising Caribbean Feminist Thought. In its framing, Caribbean Feminist Thought aims to disrupt the monolithic narrative of the Black woman and capture the intersectional identities of women and girls in the Caribbean and the diaspora.

In this chapter, Figured Worlds is the glue that holds Caribbean Diasporic Identity and Science Identity together through the lens of Identity Resources. This marrying of constructs attempts to build a framework that centres the Caribbean Diaspora in a European context, not just another European country, but a diaspora in the colonising country.

Figure 2

*Depiction of Caribbean diasporic and science identities nested within Figured Worlds*

![Figured Worlds Diagram](image)

*Note: The figure shows the joining of Caribbean diasporic and science identities as subsets of Figured Worlds.*

**Figured world in science identity**

Many science education researchers use Figured Worlds to conceptualise and analyse
science identity (see, e.g., Carlone et al., 2014; Gonsalves et al., 2013; Luehmann, 2016; Rahm et al., 2021). The argument that identity is continuously being reconstructed across time and space (Carlone & Johnson, 2007) makes Figured Worlds apt as a binding to join the two paradigms of identity to build the theoretical framework in this study. Figured Worlds affords us the tools to extrapolate how participants author and eventually develop their science identities.

Figured Worlds are sociocultural in construction and imagination. These worlds require the interaction of people who then assign meaning to the artefacts they use to direct practices. As a figured world, science becomes a space where members are recruited into, enact practices of, and become embodied in their roles (Holland et al., 1998). In these Figured Worlds, people and artefacts take on new meanings that exist within one frame in the world but are not fixed to that frame. It is these social, cultural, salient moments of interaction and individual enactment that form the basis for embodiment and identity development. The degree to which one is considered proficient or novice within a figured world depends on how much they manipulate and manage these tools creatively: that is, whether individuals follow a script, or they improvise authentically in the enactment.

There are four conceptions of Figured Worlds (Holland et al., 1998) with which we will engage with in this chapter. They will underscore the constructs of Identity Resources and Caribbean Diasporic Identity. These conceptions will not be treated discretely since there is an interplay between all four of them at each structural frame, that is, the macro, meso and micro levels.

The first concept delineates that Figured Worlds are historical in their development, where members are recruited into these worlds. These historical worlds are developed through members' contributions in forming traditions over time. The second conception is that Figured Worlds are social activities in which members are positioned and are also positioning themselves. The social encounters in which participants are positioned matter since some members might be included or excluded from various activities based on their social standing. These inclusionary or exclusionary factors can be implicit or explicit in recruiting members. The third concept is that Figured Worlds are institutional in that they are “socially organised and reproduced” (Holland et al., 1998, p. 41). Similar to the second concept, members re-create these roles that participants hold. Whether the role has been ascribed or claimed by the participant, they are reinforced through actions of the participants figured into that world.

The fourth concept is that Figured Worlds populate the landscape of human voice and
tone. This concept deals with the fact that the actors of the world in which they are configured actively carve out the space they inhabit through their cultures. For example, activities that transmit their heritage from one generation to another include languages, traditions, folklore, and performances of dances and songs that represent the heritage. This means that the actions of the actors in the worlds are connected to the place and, through their "senses of self across many different fields of activity" (p. 41), are distributed across time, space and place (Holland et al., 1998).

With respect to (science) identities, Holland and colleagues (1998) summarise that these are historical in development and are nurtured and evolved through the constant activities members of a group take on, activities which are demarcated by how members position themselves and are socially organised themselves. When we apply this to the Figured World of Science, we can say that this world is a microcosm of society and people because it embodies hierarchical ways of being and belonging that govern societal norms and mores.

**Science Identity Construction**

Science educator and researcher Maria Varelas (2012) notes that science identity is "multidimensional, multifaceted, and complex." (p. 14). Similar to positionality, identity is under continuous construction and reshaping as learning occurs in formal and informal spaces (Adams & Gupta, 2017; Avraamidou, 2014; Varelas, 2012). The underlying assumption in science identity stresses the ascriptive nature of identity, that is, the effects that others’ positioning has on an individual’s identity. To counter this assumption, we emphasise that science identity is “recursive and dialectic” (Alexakos, 2015, p. 200): it is fluid as it is complex, highly contextual and evolving through our life stages of development.

As Stuart Hall’s (1997) use of the word identification to signal a process undertaken in moulding one's identity, we define science identity herein as identity that is provisional, always ‘in the making’; it is not at a place of completion or finality. Science identity is a site of constant negotiation between the “I” that represents the self, that is, our own identities or “desired identities”, and “others” (Avraamidou, 2020, p. 340), the identities that are assigned to us.

We borrow from Holland et al.'s (1998) use of Bakhtinian's "space of authoring" to explain a sequence of identity development. Along this continuum, one moves from a neophyte, giving over to others, to the experienced--who then can "rearrange…and reorchestrate"… their own "authorial stance" on who they are or what science person they want to be (p. 183). Hence, we chose to use the word science identity authoring instead of science
identity development. In the chapter, Red is the bricoleur drawing upon the resources within her Figured Worlds of science, Community Roots, home, and school, to author her world of science; that is, her science identity.

April Luehmann (2016) argues that "identities are constructed as we position ourselves, and we are positioned by others" (p. 24). This positioning reinforces the social interactions in Figured Worlds that are crucial in identity construction, with social interactions that are contextual and dialogic. Holland et al. (1998) posit that in the figured world of dialogism, the vantage point rests within the “I”, and authoring selves come from the “I” (p. 171). This vantage point is ascribed to us, and it is from this position that we view the world.

The dialogue is, therefore, between the “I” and the world from the perspective we hold. This point is supported by the argument forwarded by Godwin et al. (2021), in examining STEM identity, argued that "there is not a universal STEM identity but rather multiple STEM identities, depending upon the individual and context in which [they are] situated” (p. 269). With these theoretical groundings to this research, we argue that Red’s science identity undergoes constant (re)construction and co-construction based on the resources she accesses in the environment - including the relationships with peers and facilitators in the programme, the materials she engages with, and how she sees herself.

To investigate Red’s science identity authoring, we use Nasir and Cooks’ (2009) Identity Resources as the lens in analysing the data. Nasir and Cooks (2009) adopted the concept from Cote and Levine (2004) to consider teachers' identities and examined how their learning was supported in a track and field programme. Identity Resources is broken down into three components: Material, Relational and Ideational. Material resources are considered physical artefacts in the context, relational resources are the interpersonal connections to others in and outside the context, and ideational resources are ideas about how one sees themselves and their relationship to place and the world (Nasir & Cook, 2009).

**Figured Worlds and Identity Resources**

There is an overlap in all three Identity Resources within the Figured World construction. For instance, material resources can be defined as the artefacts or tools employed in Figured Worlds. Material resources are in the construction of the world and are figured in the everyday performances and activities of the members of that world. In this chapter, we define material resources as the tangible and tactile items that are part of the lessons and activities the children and their families engage with in Community Roots. These
resources are also present in school and at home. We focus primarily on the home and Community Roots. The material resources are present at the meso level, which is the physical and the intangible, metaphorical space of the centre and the programme, a space which is curated to invite participation and engagement.

Relational identity resources are present in the interactions between all people in the programme, which are also evident in the home and school. The relational resources happen at the micro level in intra- and interpersonal interactions. However, important to note is that relational identity resources are also reinforced at all three levels in the macro-, meso- and micro-structures. Finally, the ideational resources happen at the macro level but are reinforced in the micro and macro levels of interaction.

These ideational resources are present in the emotions expressed during the activities in Community Roots and individuals’ experiences with science in school and the perception of science in Community Roots. Finally, ideational resources are present in the macro structures of Dutch society and how individuals are being positioned socioculturally.

**Caribbean Diasporic Identities**

*The Diaspora*

*Scattered...  
...Fragmented  
Coalescing in the  
In-between spaces*

The diaspora means living away from your country of origin. More pointedly, it implies the movement of a group of people, a collective displacement or dispersion. The etymology is from the Greek word diaspeirein, to disperse, where 'dia' means across and 'speirein' means scattered (Lexico.com). The diaspora has come to embody the Caribbean experience (Adams, 2013). The Caribbean diaspora, hereafter the Diaspora, is formed from the scattering of, that is, the displacement of peoples: from the Indigenous Arawaks, or Tainos and Caribs, whose ancestors crossed the Bering Straits, to the Africans brought on slave ships, to the voyagers, and European settlers and indentured servants (Adams, 2013; "Indentured Servants in the US", PBS), enslavers, plantation bakra masas* (slave master in Patois, Jamaican creole), to the Asian peoples who came as indentured servants, to the more recent waves of migrants who have come to settle in the Caribbean.

Thus, there is a diaspora within that characterises the Caribbean and the diaspora outside the region. What Stuart Hall (1997) coins as a "double diasporisation" (p. 25) of the
Caribbean, especially those of the African Caribbean diaspora—we are a people of "uprootedness" (Pacquet, 2002, p. 6). Nonetheless, it is in this spirit of uprootedness that we have come to embody—to carry in our bodies and, thus, plant and be rooted wherever we go—the routes (ode to Paul Gilroy and Stuart Hall) we travel come to stand in for the roots that are planted.

The Figured World of the Caribbean Diaspora can be explained as history-in-identity making. Carole Boyce Davies (2013) writes that "history ensures some distinct markers on land, in and on the bodies of the people, in and around created communities" (p. 3). These markers are then transposed onto the cities in the migrant lands where we are transplanted. The Diaspora populates the migrant land with their spirits, food, music, dance, and creolised tongue (Boyce Davies, 2013).

Though the diasporic experience is not limited to the Caribbean, it is the focus of this study, the Dutch Caribbean Diaspora, in particular. Stuart Hall (1997) explains the specificities of the Caribbean experience of displacement and 'diasporisation':

Caribbean cultures, like most diasporic cultures by definition, are usually (largely) forced migration. They are born of travelling, rupture, appropriation, loss, and exile. A kind of spiritual homelessness lies at the centre of the diasporic experience (p. 27).

The word diaspora is troublesome; it is not a one-size-fits-all term (Hall, 1997). And, matched with diaspora, identity, too, is a problematic word. Here we use an analogy from the 1993 Walt Disney film Cool Runnings, directed by Jon Turtletaub, to illustrate this point. There is a famous scene in the film where the character Sanka Coffie, played by Brooklyn-born actor Doug E. Doug, says to his teammate, in a moment of national pride and attempt to rouse morale, "We look Jamaican, walk Jamaican, talk Jamaican, and is Jamaican, then we … better bobsled Jamaican." Here the presumption is if you look, walk and talk in a way that resembles the national culture, then you simply are figured into that cultural world.

However, this is not always the case. For example, the point of study in this paper is the Caribbean Dutch in the Netherlands, for whom 'Ik spreek Nederlands' (I speak Dutch) does not equal 'Ik ben Nederlands' (I am Dutch). To speak the language, to be enculturated in the ways of being Dutch does not make one Dutch. In fact, the Caribbean Dutch-born person is still considered a migrant even up to the fourth generation (Smith et al., 2022). The Dutch citizenry is divided into two groups: autochtone (native) and allochtone (foreigner). In her book, White Innocence, Gloria Wekker (2016) discusses the point that to be Dutch, that is, "belonging to the Dutch nation", requires shedding the features that do not commit to the "…collective imaginary consider[ed] non-Dutch." (p. 7).
Nationality is entangled, as is diaspora, and the word 'nation' is intertwined with race and ethnicity (Hall, 2017). Hall (2017) notes:

All identities must significantly mark their similarity to and difference from something else-for, meaning is relational and positional-then every identity, however provisional, asserts itself, must always have a symbolic 'other', which is what defines its constitute outside. The difference lies not in whether there is, in fact, such an Other [emphasis added] to which our identities relate, but in whether the representation of that is fixed and degraded, so it becomes the object of symbolic violence (p. 128) within a binary order of representation as to reduce, condense and polarise such differences. (p. 131)

In positioning oneself, the Other becomes a point of reference. Similar to the multiplicity of identity, there are also multiple positionalities. Hence, the Caribbean identity is not a singular one. Still, within the different ethnicities of African, Asian and Europeans that coalesce on the islands of the Archipelagos and the Guyanas on the horn of South America and the Caribbean Sea coasts of Colombia and Venezuela, we are a hybrid. A hybrid of displaced peoples. The cultures and geographies of the Caribbean region are a hybridised mixture of language, history, and heritage.

Hybridity is a word used to describe Caribbeans abroad, mostly about the second-generation Caribbean children born to parents from the homeland, living in their migrant homeland, primarily in the metropolitans of the United Kingdom, Netherlands, France, the United States, and to a lesser degree, Australia and New Zealand. Hybridisation is never complete (Hall M.L., 2007). Hall's (2017) definition of identification as a process is in the positioning ourselves with respect to the place that we are in. Similar to identity and positioning, hybridisation is context-bound and multi-dimensional.

For example, a young Black Caribbean girl in the United States might find her Blackness more salient in most places, and her Caribbean-ness takes centre stage to a lesser degree (Smith, 2022). On the other hand, Caribbean-ness might be the foremost identity marker for a young Caribbean girl in the United Kingdom. For a young girl from the Caribbean Diaspora in the Netherlands, zwarte (Black) might not be a term used to describe her being of Afro-descent in the Netherlands. In fact, zwarte to describe someone's race is not used since racial discourse is not a part of the everyday parlance of the Dutch populace. This norm might stem from Dutch society's reluctance to discuss race and ethnicity openly. Gloria Wekker (2016) explains that 'of colour' is often described as "een kleurtje hebben, 'having a tinge of colour' " a diminutive way to express that one is of colour (p. 7).
We opt to focus on colonised rather than racialised identities since using colonised allows us to highlight how the discourse on race is treated in the Netherlands or Western Europe. In her seminal work, *Everyday Racism*, Essed (1991) argues a different brand of racism in Europe, unlike in the United States, where the story of the “Black Diaspora in Europe… is one of colonialism, not slavery” (p. 14). Whilst race and racism are in the bedrock of American society: the machinery of the plantation colonial enterprise and attempted genocide of Indigenous groups is similar to the Caribbean region. In Europe, the mother countries, The Netherlands, The United Kingdom, France, Belgium, Spain, Portugal, and Germany, outsourced their colonial projects (Torres Olave, 2022). The European citizenry did not have to deal with the face of the Other in their slaveholding colonies. It was exempt from their psyche, in a state of wilful ignorance. In post-World War II, there was a rise in immigration from the colonies as people were recruited to rebuild western Europe, including the Netherlands. And, at that point, unlike before, Dutch natives were coming into close contact with the colonial Dutch citizens.

The intersecting macro, meso, and micro societal structures of colonised, ethnic, and gendered identities are entangled with our context's economic and political happenings. We pause here to hastily add that social class is a salient construct in the intersecting identities that affect the lives of marginalised groups. Unlike the ways in which we attempt to unpack colonial ties as it relates to the Caribbean Diaspora; classism is not taken up in this paper since it was not fully explored in the research context.

We also realise that in the Northern European context, classism cannot be viewed through the lens of North American class-based discussions per se. Therefore, for us to give due justice to the nuances of how classism is played out in the northern European context, we would need to delve deeper into the ways it permeates society while, at the same time, it is obscured from discussions and how it is just as intangible and fleeting but nefarious as race and racism in Europe. We thus acknowledge that class capital is at the crux of science capital (Louise Archer et al., 2015), though we do not dwell on socioeconomic status as a construct in this paper.

**Figured frames of doing and undoing in the Diaspora and science**

Figured Worlds are organised and reproduced through acts of doing – the first and third conception of Figured Worlds. Participants are recruited into Figured Worlds that are historically and socially formulated and recreated (Holland et al., 1998). Drawing on Judith Butler's (1988) conceptualisation of gender as performative acts that are crafted through
"social sanctions and taboos" (1988), the Diaspora is figured into and constituted from acts of doing.

The frames that can be applied here are two-fold: one is the melding of cultures and histories from the land of origin to carve out an identity, and the other is the oppressive act of objectification—in colonial history where Indigenous, enslaved, and indentured peoples and the land are to be dominated. These acts connect to the fourth conception of Figured Worlds and speak to identity-in-the-making, where the actors across histories and continued participation in the actions give voice and meaning to the land - metaphorical and physical (Holland et al., 1998).

This connection is evident in the previous paragraphs where we alluded to the acts of doing as becoming in a new place, the embodiment and transposition of culture, in carving out space—the liminal space in-between home and longing, where the Diaspora attempts to re-form their identities. Boyce Davies (2013) discusses Caribbean poet and academic Marlene NourBese Philip's essay, *Dis Place: The Space Between*, where dis place in the in-between, the liminal space, symbolises the colonial relationship between master and enslaved, one in which the body is ruled over and becomes property of an economic enterprise.

However, as much as there is domination, the Diaspora still whittles out a space to re-claim personal power, personal power—their agentic power mediated by positionality and relationality (Boyce Davies, 2013). This colonial-subordinate relationship plays out more in the metropolis of the empires where the Diaspora traverses in the quest for a new life. We turn once again to Boyce Davies (2013) to expand on the colonial-subordinate relationships that are characterised by objectification and dominance. In the following excerpt, Boyce Davies (2013) draws attention to the tensions present in *dis place*, the liminal spaces the Diaspora encounters in the metropolises they reside:

> The politics of location brings forward a whole host of identifications and associations around concepts of place, placement; location, dis-location; memberment, dis-memberment; citizenship, alienness; boundaries, barriers, transportations; peripheries, cores and centres. It is about positionality in geographic, historical, social, economic, and educational terms. It is about positionality in society based on class, gender, sexuality, age, income. It is also about relationality and the ways in which one is able to access, mediate or reposition oneself, or pass into other spaces given certain other circumstances. (p. 153)

In Sara Ahmed's (2007) essay on the *Phenomenology of Whiteness*, she discusses the
racialisation of whiteness, in that whiteness is cultivated in doing. The acts of doing symbolise objectification and domination; whiteness is "'real', material and lived" (Ahmed, 2007, p. 150). As Sheila Jasanoff (2006) argues, empires "engender and depend on feelings of belonging" (p. 289). These feelings of belonging are cultivated through integrating cultural practices such as practising national holidays and requiring a common language in administrative and judicial services, commerce, and technology (Jasanoff, 2006). The impact of these integration practices is hidden and unseen, yet they are sensed and felt and direct the ways of life. Here cultural identity is wrapped up in the acts of doing.

Additionally, another Figured World that comes to the fore and is dialectically shaping the Caribbean Diasporic identity is that of whiteness. In the second conception of Figured Worlds, participants’ positioning is enacted and socially constructed. Therefore, the Caribbean Diasporic Identity is formed through a dialectic dance of domination and subordination. In this paper, we render whiteness as an identity, an orientation that is defined by juxtaposing it to Otherness. This juxtaposition also mediates the Caribbean Diaspora's positioning. The doing is ontological and an axiological act that takes up space without being seen or recognised--explicitly called out.

The Figured World of the Diaspora is imagined in its historical psyche, the collective agency and consciousness of the people, the actors performing these dialectic acts of claiming space and marking their existence. In the case of the Diaspora, the taking up of space is in the acts of indigenising the place we inhabit-- the carnivals, the patty shops, the food, the marketplaces, the colours, beats, sounds, and accents of the mother tongue (creole), the fashion, the hairstyles, and dominoes at the table (Boyce Davies, 2013). The Diaspora is bred in the Figured World in dis place, occupying the liminal space -- an in-between space. It is hybridised space of non-belonging—a dialectic dance neither in the homeland nor the foreign land.

We argue here that the domination of whiteness and its subsequent position of privilege and power is parallel to whiteness and power embedded in science. Sheila Jasanoff (2006) explains science and technology have served as tools to perpetuate the colonial traditions hidden behind the discourse of development and advancement. A striking historical example of this machination is Darwin's, dubbed the father of evolution, voyage on the HMS Beagle (1831-1836) as the ship's naturalist whose task was to document the species they found on distant shores (National Geographic, n.d.). What was the purpose of this documentation? Jasanoff (2006), in citing Matthew H. Edney's (1996) Mapping of the Empire, argument offers an explanation here:
Anthropology, botany, ecology, geography, linguistics, and even early forensic sciences have deep colonial roots: to rule effectively, occupying governments had to map their territories, classify populations into identifiable groups, and catalogue flora, fauna, languages, and cultural practices. (p. 280)

The "extractive and exploitative" (Jasanoff, 2006, p. 281) arms of the colonial enterprise did not only extend to its outposts abroad. It also laid the foundation of many informal science learning institutions, such as botanical gardens, zoos, and museums. We have witnessed over the years many museums in European countries, including the Netherlands, have returned or are being encouraged to return artefacts to their countries of origin, partly in an effort to address their implicit roles in upholding colonialism and racism (Moses, 2020).

There is an act of doing science for which enactment grants one membership to the group. Science is positioned as creating an insider/outsider binary--to "reduce, condense and polarise such differences" (Hall, 2017, p. 131). Here we re-emphasise the point made in the earlier section that science is a socially and culturally constructed figured world where certain acts are assigned significant meaning, and particular performances are valued over others (Holland et al., 1998).

The cultural world of science, as earlier argued, is manufactured, and developed within the masculine white Eurocentric figured world and is in a constant state of conflict, as member participation requires constant mediation of other Figured Worlds; for instance, through the roles, we play at home, amongst our peers, at school and within our gender, ethnic, and religious identities. Subsequently, individuals who fall outside this purview learn to nurture their becoming and being science persons, carving out their science paths, in dis place, the liminal spaces--the in-between space.

There have been calls in the science education community to decolonise science education curricula and disrupt the practice of doing business as usual without attention to the ways in which science education perpetuates the deficit view of disenfranchised voices and images of marginalised groups in the science community (Smith et al., 2022; Rosa & Mensah, 2021; Bang et al., 2012; Strong et al., 2016). There is a need for science to be culturally relevant and inclusive, and that begins with disrupting a narrative that turns a blind eye to the colonial influences in science education.
Resilience and science identity

Resilience in science education has been described as a coping mechanism, especially in research on African American women in higher education and postgraduate studies (e.g., Ferguson & Martin-Dunlop, 2021; McGee & Bentley, 2017; Morton & Parsons, 2018). As Ebony McGee and Lydia Bentley (2017) assert, young people from all walks of life, regardless of socioeconomic or racial background, need and use coping mechanisms to navigate and transition through the various developmental changes in their lives. Danielle Ferguson and Catherine Dunlop-Martin (2017) describe the process by which African American women experiment with different strategies to help them navigate structural and systemic barriers in their academic pursuits to achieve success as ‘creating resilience’.

We lean towards this framing of resilience - created and built up over time - for the purposes of this chapter, as we see our participant, Red, build up resilience in Community Roots, the Saturday science programme highlighted herein. We see resilience as dialectical and cyclical, creating a feedback loop that produces behaviours that engender success. Whilst it is a coping mechanism for Black women in STEM (Ferguson & Martin-Dunlop, 2021; McGee & Bentley, 2017; Morton & Parsons, 2018), it becomes a soothing balm that simultaneously masks the trauma experienced by Black women as a result of the unacknowledged oppressed intersecting identities that are barriers to their success in STEM (McGee & Bentley, 2017). The dark side of resilience (Mahdiani & Ungar, 2021) is that it places the onus on the individual to be resilient rather than changing the individual’s environment to be more just. We contend that individualistic, neoliberal perspectives on resilience are particularly problematic for marginalised groups, especially Black women and girls. We see a strong need instead for dismantling the societal structures that require resilience as a necessity for survival.

This chapter offers a view of resilience-in-action, a visual representation of resilience. Whereas other studies provide evidence of resilience through interviews, with resilience reported on as a coping mechanism, the participants build up over time; herein, we show Red’s actions in the moment as she works on a project. We see resilience in the moment acting as a feedback loop, and we conclude that resilience is dialectical to the successes that Red experiences. In addition, this chapter offers a view of resilience that is celebrated and associated with emotions. We see the emotions stirred in response to success and failure that also influence this resource of ‘resilience-building’ in science identity authoring. We witness in this chapter micro-moments in Community Roots where pride, joy, and curiosity get us to the cycle of failure and success, which in turn adds to the foundation of building resilience,
which informs the science identity in the making.

**Emotions and science identity**

Science identity research has taken up emotions as a construct that supports participants in science identity development. We reported earlier that emotions are a key component in the resilient-science identity authoring loop. We see where emotions are the impetus to building resilience and seeking success and adding to science identity in the making. As Lucy Avraamidou (2021) argued, emotional labour is embedded within science engagement. Some individuals are constantly negotiating for their place in science, and the emotions that come with success and failure to situate oneself in science are laborious. This emotional labour influences a person’s identity ascriptions, i.e., Do I see myself as a science person? Do others see me as a science person? Am I ‘good’ at science? Do others see me as a ‘good’ science person or not? Do I want to become a scientist? Do I want to devote time to pursuing a science career? We see the emotions that these constant musings can potentially raise for a child as they engage with science. On the micro-level, taken up in this chapter, the emotions at work as Red cycles through successful and not-so-successful attempts at the activities she is engaged in are silently authoring her science identity (or not).

The emotions expressed through analysis on a micro level are closely connected to the meso and macro levels and help us and Red construct our social realities. In our research, an example of a meso level is the enactment of culture in the science programme Community Roots. The macrostructure would be the use of educational practices such as *stacking* and *tracking* in the Dutch education system - though unseen in their effects, these influence Red’s academic success (Smith at al., 2022).

We will shed light on these two practices in later sections of the chapter. As we zoom into the emotional states experienced at micro-levels, it allows us to form strong bonds, attachments, and commitments at all levels of social reality, or rather social life. It is these micro level emotional states that generate and reinforce the social commitments that connect us to structures and cultures at the meso and macro levels (Turner, 2010). As Jonathan Turner insisted, we “are not ‘lost’ in sociocultural space between the micro and macro because the forces of the micro and macro realms are constantly generating pressure on persons and corporate actors” (Turner, 2010, p. 273).

**Research questions**

This chapter examines how Red is enacting her different selves or multiple identities
of being in the world, in other spaces. In an effort to construct a more nuanced understanding of the experiences of children in science education, and especially those from communities that have been marginalised in juxtaposition to the dominant culture, this work is guided by the overarching question: How does the interplay between three different structures: the macrostructure (diaspora) and meso-structures (the science programme) and the microstructures (the relationships the individual has with oneself and others), inform a Caribbean Dutch girl's science identity authoring?

More narrowly, the research questions that guide this chapter are:

A. How does identity authoring show up for Red in a community-based science program?

B. How are identity resources manifested in Red’s experiences with science, and how do they support/or not support her science identity authoring?

**Research design, participant, and context**

**Research design**

The study follows an ethnographic case study within case study defined by a 12-year-old Caribbean Dutch girl. Ethnography has been adopted in the fields of social and educational research to understand and analyse the "perspectives and actions of how people see themselves and the world" (Hammersley, 2006, p. 4). Aligned with our bricolage approach, we incorporated the case study approach in the critical ethnographic fieldwork. The case study approach, similar to ethnography, emerged from the social sciences of anthropology and sociology (Hamel, Dufour & Fortin, 1993) and has crossed over into other disciplines such as education. Designed to bring to light the social and cultural experiences of daily living, case studies include observations, interviews, and documentation of various sources to achieve this purpose (Hamel, et al., 1993).

Through a full immersion into the context of the study and the triangulation of data collected, an ethnographic case study offers a rich and in-depth study of a particular social context. Herein, the case study of Red allows for exploring how a Caribbean Dutch girl positions herself and is positioned (or whether she is allowed to position herself) in a community-based science enrichment programme—adding to the conversation on the ways in which non-dominant cultural groups interact and build identities within the Figured World of science.
Authors’ roles and positionalities in the study

Participant observation (Yin, 2003; Spradley, 1980) is used in ethnographic research to gather data from the field as one participates in activities as well as observes interactions within the study context among participants. As Spradley (1980) posited, ethnographers are not merely passive observations of activities but experience the activities of participants to get a feel of the occurrences created, and enacted by participants and to record perceptions of what is interpreted in these events. Except for the third author, the authors are participant-observers in this study.

The first and fourth authors were responsible for co-creating, implementing, and executing the programme. The second and fourth authors attended some lessons and participated in activities with families and some of the data collection. The first, second, fourth and fifth authors met biweekly to discuss the progress of the programme and the research component of the study, and they were all involved in building the framework and creating the tools for data collection. The third author was involved in the data analysis and interpretation of the study. More will be said about the roles of each author in relation to the data analysis in the methodology section of this chapter. It is important to note that the first author floated between moderate and active participation in the activities of the programme and observation as an insider and an outsider in the study. The first author was an active participant in planning, preparing, teaching alongside, and engaging with the programme facilitators, participants, and co-participants.

In mirroring feminist and critical ethnographical methodologies, ethnographers offer a social critique of the systemic issue to disrupt the colonial structure of traditional ethnography where it appropriates and represents the ‘Other’ (Sullivan, 2013) through a colonial gaze. As researchers, we want to highlight the reflexivity, reciprocity and intersubjectivity between us and Red, the researchers and the participant (Reeves, Peller, Goldman & Kitto, 2013). All the authors come to this study from the lens of persons of the diaspora relative to their own heritage, backgrounds, and geographies. Each author currently resides in a country that is not their homeland or the homeland of their fore parents.

They each walk diasporic routes as they study, work and live, setting down roots and occupying dis-place, the between, the liminal space. Each author has their own diasporic story: the second author being Spanish lives outside of Spain; the third author being German- and Italian-American living in Europe; the fourth author lives in northern Europe outside of her country in the Mediterranean; and the fifth author, who is AfroCaribbean-American lives...
outside of the United States and the Caribbean. Overall, common to all of them is having a diasporic experience, a salient feature of this study. The experience of non-belongingness and constant presence of occupying this in-between state characterises liminality. Summed up in this sentence, as Hall (2011) laments, “Whenever I go back, I think I am home, but still I am not home” [emphasis added] (p. 668).

In further examination of the researchers’ positionalities, the first author laid out her multiple identities—a bricolage of identities, if you will—in the introduction of the paper. These aptly position her to examine the complexities associated with identity and give her a unique insider's lens. This insider’s lens is akin to Paula Moya’s (2011) perspective on the Argentinian feminist philosopher, María Lugones, work on identity, viewing identity from the perspective of that of the pedestrian—the axial positioning that gives the researcher a clearer picture of how identity is fluid, contextual and rooted in the very experiences of our existence.

The Dutch Caribbean and Surinamese communities have an immigrant/newcomer status, though this status becomes hybridised as generations stay in the Netherlands. They identify as Dutch; they are Dutch. Their positioning in the Dutch society can be described as one of being on a continuum. Likewise, the first author positions herself on a continuum as an outsider/insider in the ethnographic pursuit as she concurrently served as a participant-observer in certain situations (i.e., engagement in science activities and co-constructing identities) but also as an outsider in others (i.e., she is not part of their everyday experiences or a member of their communities).

In qualitative research, when the boundary between the researcher and the 'researched' is blurred, and the reflexive nature of the "I" disrupts the positivistic claim of objectivity, this then demands that the researcher position themselves in their research. As Hammersley (2006) puts it, the "tension between trying to understand people's perspectives from the inside while also viewing them and their behaviour more distinctly" is essential in ethnography work. We argue that the first author’s positioning as an insider and revealing her narrative sheds light on the multiple identities at play for both her, the participant, and all other stakeholders in the study. This allows the ways in which our stories depart and come together to present this ethnographic case study and tell the story of one participant: Red.

The case of Red

Red started the Community Roots when she was in the last year of primary school and continued the programme when she started high school. Her two maternal aunts, Aunt Mary
and Aunt Sonny, share custody following her mother's passing. Her maternal family is from St. Martin. She has a network of extended family support as she lives with Aunt Mary and her uncle, her aunt’s husband, and her brothers and cousins. She would be dropped off and picked up by her aunt or uncle, her aunt’s husband or she would ride her bicycle when neither adult could take her. This is notable as she lives a great distance from the community centre compared to some of the other families.

Red is a typical teenager who during her free time watches television, spends time on her mobile phone and is locked in her room to her aunt’s chagrin. Red wants to be a nurse like her late mother, who was a nurse practitioner. She swims competitively and goes to practice once a week. She is a very good student in English that her friends would validate and does well in her studies and strives to get high grades over 7/10 (Dutch grading equivalent to B+ in the US context). Evident of her persistence in getting good grades, she shared a story of having a conflict with her English test and confronting her English teacher over grades. Red could be described as spunky, quiet, and observant.

Red’s Aunt Mary signed her up for the programme. She was the oldest in the group and attended all the sessions. When the programme reopened after covid lockdowns, she was one of the only Caribbean girls that continued the programme, and she continued coming even when her peers did not return.

The ‘only-ism’, being one of only a few handfulls of groups from marginalised groups in science spaces, especially for women and girls of African descent, is documented in the literature (Joseph, 2020). Similar to the first author, an AfroCaribbean who has experience being among the few or only one in the science courses pursuing a science degree or at institutes or professional development as a science teacher (author, 2022), Red’s experience affords us further insights into this phenomenon in a north-western European context of the Netherlands.

Figure 3

Red’s possible trajectories through the Dutch Educational System
Note: This figure shows the different levels in the Dutch education system and pathways (routes) Red might take for achieving her goal of being a nurse. [https://www.nuffic.nl/en/education-systems/netherlands/chart-dutch-education-system](https://www.nuffic.nl/en/education-systems/netherlands/chart-dutch-education-system)

The Dutch educational system is divided into three distinct groups. The first track is a four-year program that leads to a vocational certificate (VMBO and MBO), which can lead to a college that offers an associate degree. The second track is a five-year secondary education that leads to a general high school diploma (HAVO) which can lead to a professional university degree at a university or institution of applied sciences. Lastly, the third track is a six-year pre-university program (VWO) that allows admission to one of the Dutch universities (Vedder, 2006).

For Red to realise her dream of becoming a nurse-midwife, she must complete her master’s degree. Having been tracked into vocational training, she will then need to stack her degrees in order to reach her goal. Therefore, Red’s professional training can follow the right side of the diagram above—take route A or B (see figure 2). She is locked out of the straight path, which is route C because she is already tracked into the third track for high school. Thus first, she will need to complete theoretical VMBO education in four years before completing an MBO secondary vocational training.

During her MBO training, she must complete more than the minimum one-year requirement before moving on to an associate degree in nursing. After gaining an associate
degree and going through 3 different certificate programmes, she will have basic nursing training. However, she must complete a 4-year bachelor's degree at the HBO, applied university, level for full professionalisation. Finally, she will need to complete a master’s degree (route D) in order to become a midwife.

Layering together with figure 2, figure 3 reveals an understanding of how Red is positioned or she is positioning herself. For example, on a macro-level, she is positioned by society as from the Caribbean Diaspora. Another example, from the macro- and meso-perspective, is that she is positioned by the school system as she is tracked into the vocational track and thus will need to stack her degrees to achieve her goal. In the programme, the interactions she has with the facilitators are on a meso-level, and the intra-actions and how she positions herself are on a micro-level.

Figure 4

**Interpretations of Red’s positioning in the programme, school, and society**

![Diagram](image)

*Note:* This figure shows the different perspectives from which Red is positioned and how she positions herself.

**Context**

The context is defined by a community-based science program, Community Roots (Adams & Pieroni, 2019), defined as a place where instructors, facilitators, children and their
families, and the curriculum interact and constantly inform each other. The Buurt
(pseudonym) is a neighbourhood located in a municipality in one of the northern provinces,
of the Netherlands. It once was a farming community but has grown to 13000 residents in an
urban city with a population of 202 810 (www.cbs.nl). The Buurt is considered one of the
most multicultural neighbourhoods in the municipality and is characterised as a working-
class neighbourhood (van der Kaaden, 2017).

Community Roots: The programme, curriculum, and recruitment

The initiative was a 20-week community-based STEAM enrichment program that
drew on science, technology, the arts, the environment, engineering, and mathematical
disciplines. Initially, the curriculum design was framed by culturally adaptive pedagogies.

The first five weeks of the program were held in February and March, but due to steps
taken by the Dutch government to combat the spread of the COVID-19 virus, activities were
postponed until September to December. During the time the programme was on pause, and
we were not meeting, we reached out to families to engage them in activities that they could
do at home. For these home activities, we asked the families to make videos of themselves
while they did the activities or take a picture to share with us; for example, science videos
were made based on the University of Groningen, Science centre’s Kitchen Science activity
booklet (Zpannend Zernike).

Initially, the programme was aimed at children in the upper primary grades. Yet,
younger children were permitted to attend when younger siblings accompanied their older
siblings or because younger children showed an interest. The families were recruited through
various channels, including posting flyers in the four neighbourhood primary schools, a long-
time community member acting as a liaison and recruiting families directly, advertising in an
online newspaper and a parent group, the community centre's Facebook group, and word of
mouth.

During the first few weeks, in the pre-corona period, there were 25 families
represented, with children ranging in age from 6 to 12. When the programme resumed in
September, there were fewer families in attendance due to some families choosing not to
return and adhering to the government-mandated measures, with the programme having
between eight to ten families per week participating, six of whom were regular attendees.
Facilitators for the interdisciplinary group included a varied mix of undergraduate and
graduate students and scientists from the alpha and beta sciences: physics, geosciences,
science communication, physiology, pharmacology, and psychology, who were primarily
volunteers.

Methods

Employing event-oriented inquiry

Theories are analytical lenses we use to illuminate our data nuances, contradictions, and comparisons. However, there is a duality embedded within: as theory illuminates, it also obscures (Tobin, 2008; Siry and Wilmes, SKAIDS lecture, June 14, 2021). The aperture opens up and allows us to unpack what is within our focus. Nonetheless, this focus is zoomed in from different angles and widens to capture an event in time. Event-oriented inquiry gives us the tools to zoom in and out of focus on what is happening and why it is happening in the highlighted moment in the data set to reveal the experiences in our everyday lives. Beyond responding to our inquiries about what is happening and why it is happening, there is also the question of what else is there? (Tobin, 2008). This question pushes at the boundaries of research and encourages researchers to prod deeper to uncover the lived experiences of individuals.

We opted to be led by questions of critical inquiry, i.e., what is happening, why it is happening, and what else is there? Digging deeper and searching wider allows us to present the whole picture of our participant’s lived experiences. We pause here to emphasise that the ‘pushing and prodding’ is on the part of the researchers, not the participants. As researchers, we ‘push and prod’ to analyse the data and theorise further to help us make meaning of what is happening and contribute to the field of science education.

We are interested in Red’s unique story, and thus we have constructed a case study of this one participant. According to Jane F. Gilgun (2014), an in-depth and comprehensive breadth of analysis of the findings requires a smaller sample size in qualitative research. We wanted to understand her case well; therefore, we explored to “…come to know it well, not primarily as to how [she] is different from others but what it is, what [she] does” (Stake, p. 8). As qualitative researchers, this stance reinforces our pursuit of an ethnographic case study is to “preserve the multiple realities, the different and even contradictory views…” (Stakes, 1995, p. 12) of what is happening, why it is happening, and what else is there (Tobin, 2008).

Data sources and analysis

The main data used came from interviews with Red and her aunt, video data, research reflections and analytical memoing (Saldaña, 2016). The secondary data that accompanied
the main data were audio data of the conversations of the children and their families at their tables, artefacts that include products from activities, drawings, responses in notebooks, text messages via WhatsApp, and phone conversations.

**Critical narrative analysis (CNA)**

In the analysis, we relied on Maria Souto Mannings’ (2014) work on Critical Narrative Analysis (CNA). Community Roots does not focus on the language but on the action. Can action be considered in the same theoretical and methodological light as language research? Deconstructing Red’s actions call for micro-, meso- and macro-level analyses (Souto-Manning 2014, see p. 160). Her actions are significant because they navigate and appropriate the 'system' to achieve her goals. Additionally, the resilience and resistance against the metaphorical systemic or hegemonic culture of science afforded her the tools and the victories to reach the goal (Souto-Manning, 2014).

**Interviews**

*Transcription and translation*

There were three semi-structured interviews conducted with the participants. The first was taken at the end of five weeks when the programme had to pause due to the measures set by the Dutch government to combat the coronavirus. The interview was to explore how the children viewed the programme and explore whether they had ideas of things they would like to see us do more of or less of or new things to introduce when we resumed. Before the interview, the first author called all the parents to find out how they were, explain what we wanted to do, explain who would be doing the interview, get their permission and also schedule a date when the families and children had time to do the 30-minute phone interviews.

As the programme participants were children, the first author communicated directly with the adults regarding setting up the interviews, and the families mediated all conversations between the first author, the primary researcher, and the children. Over time, the family and child became a single entity in the project. For example, when the programme went exclusively online and communicating through texting was the only way to engage with the families, Aunt Mary created a WhatsApp group for the first author, the instructor, Jane, and Red, for all of us to keep up with the demands of going online. Therefore, with this notion of the family being a single entity, a request for an interview meant an interview with the family unit.
The interview questions were developed with two of the researchers along with the interviewer, a native Dutch speaker and a master’s student at the time. Once the interview was scheduled, the master’s student conducted the interview with Red and her aunt. The interview was transcribed by the student and the Dutch version was then translated into English and checked for accuracy of Dutch-to-English translation.

The second and third interviews were conducted after the programme, and both were an hour long. The second interview was conducted a month after the project ended. Red and her Aunt Mary were interviewed by the first author and the instructor of the course. The interview questions were developed by four of the authors and vetted by the course instructor, a Dutch native who was familiar with the families and children. Some of the questions were developed earlier in the planning according to the identity framework and with deliberation on the appropriateness of the questions for a Dutch audience. For example, using the word ‘feeling’ to probe how the participants felt about being science persons might not have been an appropriate question for a Dutch speaker, as the word ‘feeling’ does not translate with the same meaning into Dutch.

The third interview was taken four months after the second interview, and the questions were follow-up questions, including new questions posed based on the theoretical framework. Using a transcription and translation platform, the interviews were transcribed in Dutch and then checked by the interviewer, who was also the instructor in the programme on accuracy in transcription. The interviews were then translated into English in the platform and checked by a Caribbean Dutch person. Once the interviews were coded in Dutch, they were shared with Red and her aunt to check the accuracy of the transcription.

Coding

Once the interviews were transcribed and translated, they were downloaded in a word document. The interviews were read through once in their entirety. Then they were placed in a table with answers and responses in each cell. In the first coding, the first author re-read the data highlighting words that stood out in the conversation based on the research questions, literature, or framework; these were pulled out verbatim. The ‘codes’ were sometimes words that summarise the response or direct lines pulled from the sentence. This action could be described as a mix of inductive and deductive coding (Merriam, 2016). There were also reflections and memo-ing that were bracketed in the coding. The reflections were either context-bound, situated the question into what happened during the project that prompted it, or what preceded the question. They were also on what “I” the researcher did or thought
during the interview, as a more inward reflection of the author’s reflexivity. The memo-ing was deliberations of what Red or her Aunt Mary might mean in the context, for example, what preceded or prompted the question or the thought.

The second and third coding happened with the co-authors, who are experts in the field, and other critical researchers who helped to unpack the findings and give feedback on the patterns in the analysis. The discussions that arose from the coding were also recorded as analytic memo-ing as we discussed the codes and the literature theorising what the codes might mean. The first researcher documented this in her reflective journal and recorded the discussions. These discussions happened throughout the process of analysing and refining the theoretical framework as we met over the course of months to discuss each stage of the analysis and further development of the framework.

Out of these discussions about the interviews (and visual data), the possible themes arose based on the questions, framework, literature, and philosophical underpinnings. These themes were based on how we could articulate what we were ‘seeing’ and ‘reading’ in the analysis (Holliday, 2007). “Articulation is about making new combinations to create new identities” (Jackson & Mazzei, 2012, p. 5). We thought about the data from multiple perspectives and theoretical positioning in the hope to create new knowledge (Jackson & Mazzei, 2012) that would extend the literature and add to the theoretical foundations in science identity.

**Trustworthiness**

The first author built a relationship with Red and her Aunt Mary over time and communicated with Aunt outside of the enrichment programme. An example of trust-building was when the first author would text Aunt Mary when Red cycled to the class instead of being dropped off. She would then text to say Red was leaving the centre. Additionally, Aunt Mary created a WhatsApp group for the first author, instructor, Jane, Red and herself to communicate when the programme went online. These small practices helped in building a caring relationship.

The authors to ensure credibility and validity of data used triangulation of data sources, employed reflexivity in data analysis through member checking and using thick descriptions in presenting the findings (Holliiday, 2007; Koro-Ljunberg, 2016; Merriam & Tisdell, 2016). Primary sources of interviews and video recordings were supported by secondary data sources such as field notes and observations, audio recordings to establish triangulation of data. The transcribed interviews were shared with Aunt Mary and Red to
ensure accuracy. They were also given the option to view a presentation of the findings of the study. In addition, the authors followed up in the third interview with Red and her aunt to clarify their intended meaning in aspects of the second interview transcription that was unclear.

In employing reflexivity in data analysis, the first author also went through several cycles of analytical memoing (Emerson et al., 1995) with different parts of the findings set with each co-author on separate occasions to capture different perspectives on patterns and interpretations of the data (Koro-Ljunberg, 2016). The first author also went over the findings of the sections of the data with other critical researchers who work is situated in Black and Caribbean studies within science education. Furthermore, the authors presented detailed descriptions of the findings to provide convincing evidence of the data (Merriam & Tisdell, 2016). These steps were undertaken to establish the study’s trustworthiness.

Table 3

An exemplar of the coding and memo-ing process researchers engaged in that generated deeper analysis

<table>
<thead>
<tr>
<th>Data</th>
<th>Coding</th>
<th>Interpretation</th>
<th>Memo-ing for further analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewer: I would like to know: what did you think about it?</td>
<td>“Well I thought it was fun and educational. Because I could learn new things like make hovercraft, how to program and stuff”.</td>
<td>Red’s impression of the programme as being educational is reinforced by her emphasis on learning new things at Community Roots. It also shows reliability and confidence in her response as she repeats her claim in different ways.</td>
<td>The further questions this raised during rounds of coding and analysis include: What does Community Roots offer for families? What supports does the programme offer for families? What is the importance of programmes like</td>
</tr>
</tbody>
</table>
2020, following the first 5 weeks of the programme)  

Video Analysis

The first author and third author, who is experienced in video microanalysis, watched a clip from week six with Red and Jane (the programme instructor). (Note here that week six is when we resumed regular programming after being in lockdown). The first author, who is also the primary researcher, chose week six based on the reflections from her field notes and video quality. She had noted the budding rapport between Jane and Red even though it was their first time meeting each other since Jane had joined the project in September when the programme resumed after the government lifted the restrictions on gathering in informal settings. At the time of the reflection, the first author wondered if the two were drawn to each other because of their similar quiet countenance.

In following this thread of thought, the field notes generated an opening for the authors’ deeper entry into the data for analysis. This is a testament to Mirka Koro-Ljunberg’s (2016) notions of data entanglements and provocation wherein one of the roles of the data resources is to direct the researcher and eventually the analysis. Moreover, the video, which was taken by the fourth author, an experienced researcher, was a close-up range of the interactions between Red and Jane, providing a clear picture of their interactions, which journeyed the path the data laid out as we embarked on the first round of video analysis.

The authors first watched the scene in its entirety with the sound off. The decision to watch without sound gave us the opportunity to focus on the participants’ actions and interactions. Sara Wilmes and collaborators (2018) typically begin video analysis with the sound off in their use of video vignettes as multimodal data resources to give attention to and “…examine [the] moment-to-moment, embodied, multimodal and non-spoken interactions … that are often backgrounded in education contexts” (p. 5). We adopted this strategy of watching the videos with the sound off to glean as much from the nonverbal communication and facial expressions as Red interacted with her peers and facilitators during activities. After the first viewing without sound, we viewed the video again with the sound on, although neither of us speaks Dutch, this provided another lens on the moment, with participants’ voices and intonations in view.

We then re-watched the same scene with the sound off once more, bearing in mind the
questions from event-oriented inquiry (Tobin & Ritchie, 2012) ‘What do we ‘see?’ ‘What is happening?’ ‘What does it mean?’, and to push the envelope, ‘what else is there?’. This time we did a microanalysis and paused to look at facial expressions, eye movements, and other movements. Questions we raised were ‘How can we name this emotion/facial expression we see?’ ‘What might the eye movement mean?’ ‘Who is the other person?’ ‘How are they influencing Red’s behaviour from what we were seeing?’

For example, we watched the interactions with Red as Jane as Red is trying to construct a working electrical circuit, in week 6. We noted that Red was not making eye contact with Jane during her exploration until she experiences success with the circuit. At this moment of success, Red makes, and maintains, eye contact for a few seconds with Jane. Here, to help us uncover more from the data from different angles, we then layered the action with the focus questions, what is happening? Why is it happening? what does this mean? and began to zoom into the role of Red’s success for structuring the particular interaction.

We next analysed another video from week 4, first also with the sound off as we watched the video, we thought more about the framework and looked at Red’s body posture, her body in the space, her facial expressions and what she was ‘doing’. These were happening simultaneously as we watched the video. We memoed the patterns that arose in the session. We highlighted what we noted as behaviours, such as Red’s focus, attention, tenacity, smiles, joy, and pride. We then re-watched the video in its entirety bearing in mind our ‘noticings’. These behaviours became our codes which we then defined (see table 2).

Later the first author re-watched the videos with sound on from different angles, then looking for re-occurrences of these ‘noticings’, describing the minute-by-minute play of what is happening, reflecting (researcher’s inner musings) and memo-ing the what and the why of actions and what they might mean. The time stamps were recorded. Then, the first author would re-watch the videos (sound on) with the second author, whose expertise was in psychology, to ‘see’ what else was happening. Furthermore, this co-author spoke Dutch. The videos accompanied by the audio recordings were transcribed and translated, focusing on the dialogue in the videos between Red, her friends and a facilitator in the programme. The same person who translated the interview transcripts was also employed to transcribe the dialogue in the videos and audio. Other peripheral data was used to build context and reference in the discussions and analysis.

In addition, the first author presented the first clip from week 6 to other critical

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2 Note that week 6 did not follow week 5 consecutively because the country went into full lockdown the following week. Therefore, week 6 happened after we resumed the programme in September.
researchers for them to also share from their perspectives of what is happening. This allowed us the multiple perspectives of inquiry that layered the analysis of the visual data (the videos). Tobin and Ritchie (2012) emphasised in paper discussions on the use of event-oriented inquiry and interpretive research the value of having different perspectives of the same data source. They insisted that the salience of having multiple voices identifying and describing what happened in a particular event or episode, not only adds to the coherence of patterns that emerge from the data but also increases the contradictions — “perspectives that differ from the patterns” (p. 4). Contradictions are sites of catalysts in the analysis as they offer researchers knowledge for expansion of theories and ontologies (Tobin, 2012).

Later the expert co-author and the first author discussed the episodes of re-occurrences, and the patterns that came up in the videos. We discussed what these episodes meant for the implication of the research and raised questions based on the framework, for example, what resilience means and what is happening in the space and what this meant for informal science education. These discussions were part of the analytical memo-ing. Furthermore, in extending the analytical memo-ing the first researcher captured the visual data in offprint images of time stamped episodes with the actions showing the patterns that came up in the video analysis.

In the analysis of both sets of data (videos and interviews), all the co-authors came together and spent two hours in two separate meetings discussing the coded written and visual data. The analysis data was viewed through the lens of critical narrative analysis. The coded transcripts and analytic memo-ing of the video data were presented by the first author that was later discussed.

Table 4
Exemplars of coding for patterns in the video analysis

<table>
<thead>
<tr>
<th>Patterns/ Emotions</th>
<th>Description of code</th>
<th>Exemplars (Off prints, episodic narratives, or literature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilience</td>
<td>Never giving up, being persistent even when you are not winning or going slower than everyone else but keep moving forward.</td>
<td>Red also struggled to get her turbine to work. All the other girls got theirs to work. She changed her fin even after most people were gone and we had to wrap up. Even then the blades would not turn. Alex had shown us</td>
</tr>
</tbody>
</table>
how to play around with the turbine at different angles to see where the wind would catch. While I was cleaning up and I noticed she finally got it to spin, and she was smiling from ear to ear after it started spinning. (Taken from first author’s field notes, February 29, 2020)

| Tenacity | Focus or show of interest. Body posture in space, i.e., standing firm, which is being grounded and planted, not slouching. Showing carefulness. | Researchers reviewing the videos and considering what the meaning of Red’s posture. In earlier rounds of analysis, the researchers would ask the question: what does this body posture mean? |
| Joy | We recognised joy as a burst of laughter or a 'genuine' smile, that is having a Duchenne smile (Duchenne de Boulogne, 1990) -- A smile that reaches the eye where the eyes are constricted and wrinkled corners of the eyelid and the lips and corner of the mouth is upturned (see Canadas & Schmid Mast, 2017). Joy is also showing elation, joking and playfulness (see Frazetto, 2014, chap. 6) Joy boosts creativity, motivation, and intellectual focus (Frazetto, 2014, chap. 6) |
| Pride | Pride is illustrated when one is examining work with happiness/has a look of satisfaction/bliss; checking in with facilitators; seeking encouragement/validation as a form of pride (see van Osch et al., 2018) Pride is shown in one’s posture - standing tall/grounded/shoulders squared and back straight, hand akimbo, power/tree stance/standing with both feet planted tree pose (see van Osch et al., 2018) | Pride is expressed as a self-conscious and social emotion, i.e., pride resolves around the self or in relation to others (van Osch et al., 2018) |
Curiosity/Wonder
Showing a look of interest/seeking to find out more information/questioning/unresolved questions/look of puzzlement/

Other emotions/behaviours
Playfulness
Frown (not of sadness but playfulness)

*Note:* The table illustrates how different emotions or behaviours were coded. That is, what body language or facial expressions represented particular emotions.

**Findings**

In this section, we present the findings from our analysis from two major sources: video analysis of classroom activities and interactions, and the interviews with Red and her Aunt Mary. From our analyses four main themes emerged: i) Red’s perception of science and the work of a scientist; ii) occupying and embodying the space; iii) the value of out-of-school science engagement; and iv) tensions between identities.

**Community Roots mediates perceptions of the figured world of science and a being scientist**

The following excerpt is a description of Red’s perception of a scientist and the science offered in school.

*Interviewer:* Suppose you were going to become a scientist; would you know what you would like to do?

*Red:* Yes, then I would like to investigate how all kinds of viruses and diseases arise.
Interviewer: Wow, a virologist. And what do you think a scientist does?

Interviewer: How would you describe that?

Red: A scientist researches all sorts of things. For example, if a dog has a virus, a scientist will investigate what is going on.

Interviewer [translate for researcher (first author): So, I asked what a scientist does, and she said she wanted to explore how illnesses evolve and about viruses. She said that, for example, if there is a dog with a virus, then scientists investigate what is going on.

Jane (Interviewer): And are you going to other scientific groups or something? For example, do you still do a science lesson or club at school?

Red: Only in biology, but we don't do really science. We only learn things from the book.

Jane (Interviewer): I think my Internet is not working very well. What did you say?

Red: Only biology, but there we only learn using the book.

(Interview 2)

The word only suggests the limiting possibilities of school science for some students. We also see that Red seems to have a perception of what science is supposed to look like in her description of the science she does in school when she says, “we don’t really do science”. Much of school science is bounded by reading texts and related written assignments. For some children, it is primarily in community-based programmes that they will have encounters with science outside of school. We often see representation as a factor in helping students decide whether to participate in science, and we fear that if children have a limited knowledge of what engaging in science could look like, then they may walk away with a misunderstood image of what science is, or whether they can pursue science.

Another point that this passage brings up is that Red is likely aware that there is something lacking in the resources and rigour offered in her school’s curriculum. The term “only” suggests not just limiting possibilities but also conveying that there is a deficit in her curricular offerings. She seems to know what science is, and what it should look like, however, she implies that she is not receiving that in her education. There is only book learning, no hands-on laboratory exercises, or opportunities for exploring, she learns science from books and there is an awareness that her school does not support science development. This is evident when she repeats the phrase twice “Red: Only in biology, but we don't do really science. We only learn things from the book. Only biology, but there we only learn using the book.”
For us this reinforces that the school, curriculum and track she is in does not offer the material resources to support Red’ science development, nor for children like Red who are interested in science. She is knowledgeable that what is being offered to her is not science and recognises the structures in her school do not support science development. The ideational resource that is provided suggests that they are not scientists in the school environment. The bookwork that is presented as science learning reinforces that she is not a scientist at school. In contrast, Community Roots is a place that nurtures science and for Red offers the resources that reinforce her science identity authoring. We see in the following sections Red’s understanding and perception of science and how she positions herself in the world of science.

Red: I liked the one with the bees, we went looking in the garden for all kinds of insects and bees.
Red: Sometimes, at school, I see pictures of eyes, what they look like. And some scientists examine eyes and see whether there is something wrong with the eye.”
Red: the only thing that came to mind because I mostly draw eyes.
Red: And the task was about what scientists do, and I thought some scientists are looking at the eyes.
(Interview 2)

Here it is evident that Red perceives science as an action-in-doing: that is, examining, investigating, exploring and diagnosing. She also sees science coinciding with healthcare and professions. This is evident in her response: “Scientists examine eyes…see whether there is something wrong with the eye.” Red likes to draw eyes and thought that a scientist must examine eyes. To extend this further, this deduction that Red makes is evidence of the ideational resources that she draws on: she positions science in healthcare, and she also wants to pursue a profession in healthcare. This tethering to science is carved out in the liminal space of what she likes and how she positions that to science. It is very thin and has to be supported in order to flourish. There is an emotional attachment that is reinforced in the material realm where she draws what she likes, and the possibility of what science might look like from her perspective. What she has done here is figured herself into the world of science she created, one that is in the health field. In the next excerpt, we also see a contradiction arise where she is grappling with aligning herself fully within the purview of a scientist.

Interviewer: Do you think she might want to do something with science later?
Mary: I don't know. She does say that she wants to be a nurse later. But I do not know. Sometimes, what she wants to do changes. So yeah ... I'm not sure if she's going
to go that way. But you never know.

Interviewer: No, it is like that.

Mary: You never know.

(Interview 1)

Red’s career goal is to be a nurse. Aunt Mary is uncertain if this will be her final career path or if she wants to be a scientist as the interviewer questioned. Aunt Mary did not deny or negate the fact that Red could be a scientist, instead, she left it open saying she does not know if she will pursue her career of choice which is nursing or something else. Here again is recognition, implicit but still, there is a recognition that the possibility is there.

Jane (Interviewer): Do you know what you want to become later?

Red: Yes, I really want to become a midwife.

Jane (Interviewer): What do you want to be?

Red: A midwife.

(Interview 2)

Red’s aspiration had not changed over the course of the programme or the year and a half we had interacted with her. She wants to be a nurse, a midwife, in particular. Red is interested in science that involves people/the human body, i.e., a midwife. However, her brother wants to be a biologist.

Jane (Interviewer): So, he is interested in science, right?

Red: Yes, he wants to become a biologist.

Jane (Interviewer): Oh okay. And what do you think about that?

Red: I think it's cool that he wants to become a biologist.

Jane (Interviewer): Okay. Does the fact that he wants to become a biologist influence how you think about science?

Red: No, not really.

Jane (Interviewer): No? Not really or just not interested in biology?

Red: It depends on what type of biology.

Jane (Interviewer): And which type do you like?

Red: Something that involves people more, something to do with the human body.

Jane (Interviewer): And less about animals or plants?

Red: No, I don’t find that as interesting.

(Interview 3)

Red has an intimate knowledge of the content enough to make a distinction of the different areas of biology and which area she prefers. Note here that a nursing programme
would involve a lot of human biology.

*Jane (Interviewer):* So, Mary, can you tell me more about... Is it Noel's involvement in science? You mentioned that last time [from interview 2] …

...No, so tell me more about...

*Mary:* Noel wants to be...

*Researcher (first author):* He is interested in science and his school that he attends because I remember that came up in the interview last time.

*Aunt Mary:* Yeah, yeah. He likes doing those kinds of things, like the research that you sent once with to Red, you know, even though she will put in. You know, he would have taken that. He would have gone with it, you know, something like that. But that is his... His interests. He likes doing those things. He likes discovering those things. He likes to, yeah, go right deep into details, you know. Sometimes into a big discussion, often nothing, you know, like you just like to go into those.

*Researcher:* And you said they're STEM-related. Do you know what he wants to become?

*Aunt Mary:* Exactly what you want. I know he wants to be a biologist. That is what he wants to be, but he wants to go that side. To specify exactly which part, I don't know.

(Interview 3)

Here we see where Aunt Mary *recognises* Noel as the scientist. According to Aunt Mary’s views, Noel also *performs* and has the *competence* of how Mary, and by extension probably Red, perceive a scientist to be ‘*discovering things and having big, detailed discussions about his discoveries*’. Another phenomenon Aunt Mary’s conversation reveals is the gender/science identity paradigm that is not limited to Caribbean families but plays a role in our assumptions about who is perceived to be a scientist. Apparent in the line of conversation between Red, her aunt, the researcher and the interviewer were that Red’s aspiration to be a nurse-midwife did not readily fall under the purview of a scientist. Even though Red and her brother, Noel, both enjoy biology and want to pursue professions that include their love of the subject, Noel’s aspiration to be a biologist was privileged as the career of a scientist over being a midwife.

*Researcher (first author):* Do you think that you are capable? That you have the ability, Red, to become a scientist.

*Red:* hmm

*Red:* I think so, but I have to, don't have to, but then I'm going to do something that has to do with... I don't know how to explain it.
Jane (Interviewer): You can say it however you can. But I can also help. Does it involve midwifery? or not?

Red: I want to be a scientist, but I don't know if I'm going to dedicate that much time to it.

Aunt Mary: No, I was also trying to translate what she was trying to say. She would like to, but then it would take too much time, for what she really wants. And if I am understanding her correctly, is that she wants to, but then in the specific area of what she wants to do as a nurse, and not just broadly being a scientist. That's what I am understanding from her.

Whilst Red does not rule out the possibility of becoming a scientist, she is aware that the profession does require years of study. In questioning her capability, she struggles to articulate her response. She pauses, “hmm” then says, “I think so… but I have to…” finally, saying “I don’t know how to explain it.” What this tells us is that a 12-year-old has inner conflict as she is navigating the messages she is receiving. She is in a place of ambiguity and non-belonging in science that she is navigating. She is parsing through the messages she receives from school, from her home and from Community Roots and other spaces she engages with. In the earlier excerpts, we see that she is aware that the messaging from school does not support her science development. She has clearly distinguished what is and what is not science, and her school does not offer the material resources for her. This is reinforced institutionally as she is tracked in a school system that limits the possibilities of what she can pursue as a career. The ideational resources offered to her are packaged in those unspoken messages has created for her a tension of whether she can become a scientist.

Additionally, it is evident that Red perceives that science takes dedication. We see this later in the interviews when she shares that scientists need to study or that she was surprised that engaging in science would be fun. As science education researchers, we should acknowledge the temporal notion of science. Science does take a long time and it is a lifetime endeavour. As Jrène Rahm (2014) articulates, it is a life-wide and lifelong pursuit. This is another cultural stereotype of scientists that they devote their lives to science and have no free time, which could be a barrier for some children to pursue science.

Jane (Interviewer): Did you change your mind about science after being in Roots?

Red: Yes, because I actually thought it was a lot harder, that it was a lot more detailed work, but in the end, it turned out to be more fun than it looked.

In the excerpt above, it is evident that Red is reconstructing a stereotypical understanding of science, that is too difficult to do or pursue. This stereotype is popular in the
discourse around science that it is hard (Archer et al, 2010) or it is boring. Red’s initial perception of science was that it is not fun. Red’s surprise that she found science to be fun is evidence of the impact of the programme. In addition, she reports of having encounters with science only in school. She loves school and we see her enthusiasm for Community Roots not in opposition to school but as an added value.

Red [00:29:26] Yes, that woman with the drawings we were going to paint.
Jane (Interviewer): I think that was Nola. The woman who helped us paint, that was Nola right?
Researcher (first author): Nola, yes, yes.
Jane (Interviewer): And do you think she’s a scientist?
Red: It's possible.
...
Red: Oh, the one with the book.
Researcher (first author): Yes, the book. The book illustration with the dinosaurs.
Jane (Interviewer): Do you think she was a scientist?
Red: I think so, because she said she first makes it out of clay. And then she makes a sketch, a drawing, and traces it. And then, she draws it completely and stuff...
Jane (Interviewer): Can you name a few things that you do, that a scientist would also do?
Red: What do you mean?
Jane (Interviewer): For example, a trait or a habit that you have, for example being curious, that you think a scientist would have too. Do you understand where I'm going?
Red: Going to school?
Jane (Interviewer): Yeah, scientists also go to school.
(Interview 2)
In their seminal work, Archer and colleagues (2010) reported on young children between the ages of 10-11, a similar age group as Red, having a bifurcated impression of science: doing science versus being a scientist. Over a decade later, science education researchers are still witnessing this phenomenon. However, the question of what else is there we see emerging with the Red this conscious awareness that along with the practical side of doing science, the investigation and experiments and there comes the training, the cognitive workload that one has to undergo to pursue a career in science. She reveals in the above excerpts that the intellectual pursuit of science takes a long time. She is aware that the career
of a scientist requires extensive training which is reinforced in the ideational resources offered in Roots. The message that she has internalised is that there is a temporality in the nature of science, which is seldom discussed in the literature. What we do not know is if this perception is limiting or broadening her purview of what science is and if she has a place in it.

From these excerpts, we also see that material and relational resources provided for Red multiple representations of science. She entertains the possibility that the artist, Nola, could be a scientist. In addition, with certainty, she professes that the illustrator who made models of dinosaurs out of clay is a scientist. Community Roots offers resources that broadens the messaging of the diversity within science.

On another note, to come back to the argument of the liminal spaces, we see from all the excerpts that have been presented that Red is in this liminal space, a sort of middle passage if you will, of making meaning of the different messages she is receiving in the different spaces, and that she is making sense and using the resources offered to her to place herself within science. We can agree that the messages she is receiving differ and offer contradictions that she clearly is grappling with. These contradictions give rise to another message that Red might be unconscious of, which is the tenacity she will have to harness in order to pursue this long-term career. For example, Ferguson and Martin-Dunlop (2021) and Terrell Morton and Eileen Parsons (2018) reported in their studies about the resilience, resistance and tenacity women of African descent need to create and build to realise their career goals in their chosen scientific fields.

For Community Roots, the resources offered provide a form of resistance to the limiting possibilities of who can be or the narrow margins of science professions. In this hybrid space, Community Roots resists the deficit notions and cuts through the ambiguities by providing social equity and opportunities for Red to work through the tensions and thrive in the space. In counteracting the ‘temporality of science’, Community Roots offers time for children to explore which might be harder to achieve in structured class time. It also creates an appetite for science. In this regard, Community Roots offers a supportive environment to pursue science.

Community Roots creates environment for occupying/embODYING the space

This section focuses on episodes taken from three different lessons in which Red worked with different facilitators in the programme, her friends and by herself. The three lessons demonstrate Red’s resilience building-in-the-making and the emotions she displays
during the activities. The first episode is a lesson on bee identification and beekeeping, the second episode is during the lesson on windmills and wind energy and the final episode is a lesson on electrical circuits. The interpretation of emotions that Red might have experienced in these spaces are represented at the micro-level where there is an outward show. The offprints in this section present evidence of wonder, curiosity, tenacity, pride, disappointment, and joy.

Additionally, there is evidence of how the programme offers material and relational support to Red. Drawing on the interactions of facilitators, friends, and families themselves and the materials provided to engage children, evidence illustrates how the space creates an atmosphere of community and generates an affective environment during science exploration.

**Sense of curiosity and wonder**

In the following frames, the offprints are from a lesson on Beekeeping and Scavenger Hunting for pollinators in the Community Garden. In this lesson, the children were in the community garden doing a scavenger hunt looking for the insects and bees (the pollinators) on their activity sheet and ticking off when they had found the insect. The points of interest are Red’s actions as a curious learner and her sense of wonder. The offprints showcase Red observing a moth, the source of her intrigue, in the grass and tracking it with her pencil.

**Figure 5**

*Illustration depicting curiosity and wonder*
In the frames, we track Red’s actions we identified as curiosity and wonder. We see Red looking under a log where she spotted a ‘moth’, reached in, and pulled back in fright as the moth fluttered around. She then tracks its movement with her pencil. Then, when she thought it flew away saying “It’s gone”. Then she reached in again, but this time, she reached in with her hand searching through the grass for the moth (lepidoptera). She found it again and started tracking it with her pencil again. Red’s action of being so focused on tracking and observing the moth is significant since the moth was not one of the insects on the activity sheet. This action is illustrative of Red’s display of curiosity and wonder as she explored her environment and observed the insect on her own accord. It is also significant because it is evidence of the meso structures in the Community Roots that affords the space for Red to exercise her own agency during the lesson.

*Expressions of joy, pride and celebration*

In the following offprints in figures 5 and 6 depict a lesson on wind energy where children constructed wind turbines (windmills). In the lesson, the children first listened to a mini lesson on how wind turbines work, then watched a video (in Dutch on Windwollen). The activity called for them to make their own wind turbines by first building a base using four sticks and then attaching a small motor to the apex of the pyramid. Then, they had to
attach the blades of the motor to the turbine. They were to check that their wind turbines were working if they could turn on their own from the wind of the fan. The frames that follow take us through Red’s expressions of joy, celebration and pride.

**Figure 6**

*Illustration showing emotions of joy, pride and celebration*

After several tries, in this moment, Red was able to get her base to stand free of reinforcements. She gasps, excited, smiles broadly, steps back to look at her work, steps back and smiles, and does a little dance, swaying slightly from side to side, clapping her hands. She says something/motions to her friend and continues her celebration. Red is not dramatic in her motion but certainly smiling broadly (grinning) and doing a swishing of her hips side-to-side and rocking her body in a little dance. She then seeks out Alex’s (eyes) who is walking back to the table and points to her work. This is a show of pride and Alex validates and recognises Red’s work.
Emotions and resilience in action

The following offprints in figures 7-9 showcase Red’s resilience in-the-making in the lesson building wind turbines. The frames in figures 7 and 8, illustrate Red’s tenacity and focus as she pushes beyond her limit, and continues to work on the task. Also evident are her moments of pride, celebration and disappointment as she achieves success though short-lived, then her disappointment but persistence to re-engage with the assignment and continues working.

Figure 7

Illustration showing Red frowning

When Red showed Alex her foundation, Alex responded “Oh perfect” (29:09) in that very moment one side of the foundation fell, which was followed by a huge frown on Red’s face. However, though her structure kept falling apart, Red went straight back to working, even after her short-lived victory she never gave up, she persisted.

Figure 8

Illustrations depicting actions of Red’s focus and tenacity
Red continued working for another 10 minutes on building her foundation. Here she is cutting and is so concentrated on her work she just moves her body out of the way without looking up to make eye contact while the other girls are reaching around and across her to get supplies (offprint 1). Red looks on as Alex shows her what to do with her mouth in circle saying, “Oh!” This seems like she is saying “Oh I get it now.” Then she continues to work (offprint 2).

Later Red continues to work on the foundation of her windmill structure by gluing the sticks to the base (offprint 3). After gluing the sticks to the base, Red had to pull apart the base yet again. It seems like she was trying to make all the sticks even at the apex of the structure (offprints 4 to 6).

We see Red slightly turn to her friend Ariel, who is on her right with a frown on her face (offprint 7). She is making a face about her structure that she has had to take a part twice now. Yet, we see her in the next print going straight back to work. Later Red is still cleaning off the glue that is stuck to the base from the previous attempts (offprint 8). She engages with the rest of the table through smiles or eye contact when they speak or head nod. However, Red’s main focus is on her base or checking across at what Alex, the facilitator, is doing. Her eye tracks what is happening around her table but returns to her work. In this frame, she is picking the glue from the base while she glances down across to Alex’s work. Her friend,
Ariel helps her to reinforce the structure.

Here in these episodes Alex, the facilitator, recognised and validated Red’s efforts. Throughout the entire session of building and tinkering, Red checked in with Alex either directly (verbally or nonverbally through eye contact and gestures) or she glances at what she is doing. When Alex was talking to the table on a whole, she looked across at her at what she was saying or doing. Red is also able to check in with her friend Ariel for help. These provide resources to her as she engages in tinkering and are further evidence of the support that programmes like Community Roots provide for its stakeholders and participants. This evidence of support is further discussed in the next section on the value of community-based science education.

*Pride/celebration/disappointment*

**Figure 9**

*Illustration depicting emotions of pride celebration and disappointment*
Red leans back to look at and check out her work, this evident of pride (offprint 1). We see Red with a celebratory wide smile with a hand movement that might suggest a finger slightly curled, and arm pulled in as if it is a celebratory fist drawn into her side (offprint 2). Shortly after (2 seconds later) we see Red’s shoulders slumped, her body slightly angled
towards Ariel, we see her frowning and mumbling something to Ariel (offprint 3). Her facial features are contorted in a look that can be construed as annoyance and frustration. Yet again, she will have to readjust the sturdiness of the structure.

Later Red looks on as Alex explains while working on her wheel (offprint 4). She checks in with Alex who is standing beside her as Red is following her instructions closely (offprint 5).

About two minutes later Red seeks help from Bella (offprint 6). We see her working in tandem with Bella as she explains. There is a sense of community while she is working with friends adds to building community or having a community in Community Roots. Red looks on Alex as she gives instructions on how to adjust the wind turbine before returning her attention to Ariel and her ‘wheel’ (offprint 7 to 10 and again in offprint 13). Red looks as she rubs her eyes, seemingly tired, but perseveres in her work (offprint 12). In the final frame, Red checks in with Alex. She even leaves her work area to go around the table to speak with Alex (offprint 14). This is evident again of the border crossing that Community Roots allows and the support the programme afforded the children in the space. The programme is what Dunlop-Martin, et al. (2021) considers as a site of cultural brokerage. The programme acts as a cultural broker for all participants.

We also see Red’s resilience in-the-making as she pushes beyond her limit, and she continues to work. The first author had recorded in her field notes that she observed that Red had continued working well after the session was over and the facilitators were busy cleaning up.

Red also struggled to get her turbine to work. All the other girls got theirs to work. She changed her fin even after most people were gone and we had to wrap up. Even then the blades would not turn. Alex had shown us how to play around with the turbine at different angles to see where the wind would catch. While I was cleaning up and I noticed she finally got it to spin and she was smiling from ear to ear after it started spinning. (First author’s field notes)

Throughout this lesson, we provided evidence of how Red persevered and continued working on her wind turbine until it worked. The joy she displayed after working on her project could be described as pride and sheer excitement at being successful. Evident here is what we describe as resilience in-the-making, the emotions she expressed after being through so many trials when she finally succeeded are testimony of her perseverance. Johnson (2012) coins this behaviour as STEM-persisters. It is evident Red is authoring her science identity in these actions.
Making Squishy Circuits© - Emotions during lesson with the Electric Circuits

In the following offprints the figures show the emotions Red illustrated in a lesson on electrical energy where the class made Squishy Circuits©. The figures show patterns of pride and joy. The patterns reinforce that Community Roots is a space that is supportive.

Figure 10

Illustrations of pride

Pride

As this excerpt begins, both Red and Jane are nodding their heads in the affirmative looking forward [at Flo, the instructor]. Red looks pleased that she accomplished the task (offprint 1) as she sighs a sigh of relief, and Jane also looks pleased. They had successfully followed Flo’s direction. As Flo gives directions, Red and Jane are working along according to her instructions (offprint 2). They also have instructions at the table. Later, Red smiles and says something to Jane (offprint 3), as Jane leans in and starts working with the dough. They began talking (quietly) and smiling. Both had their heads down, not making eye contact, moulding the clay. (This activity reinforces Red’s perception of science that came up in interviews 1 and 2). Shortly after, Red seems to call Jane’s attention to what she is doing with the circuit (offprint 4). Jane seems to consider what Red is doing. This might be Red asking for validation of what she is doing and that she is following Flo’s direction.
Community Roots engenders and supports a sense of community in the space

The excerpt above shows evidence that Community Roots creates an appetite for science and supports how to do science.

Red: Honestly, when we're at Community Roots and we do an experiment, I want to finish it as fast as I can, because when I get home, I just don't finish it, because then I don't feel like it and I don't know what to do anymore.

(Interview 2)

When Red said “I don’t feel like it”, we saw emotions in relation to science and what initially could be described as Red positioning herself in science and having a low self-recognition in science (Visintainer, 2020). We initially memoed that Red was not taking ownership of science/does not perceive herself to be a science person. However, upon further investigation when we overlaid the analyses from interviews with the video analysis, we saw that Red’s experience with science was place-embedded meaning there are four different spaces Red interacts with science.

There are three at the meso-level: Community Roots, her home, her school and one at the macro-level Diasporic cultural space. The link to this is in the interview data, first and second interviews where Red says facilitators helped her and she says she doesn’t have the ‘resources’ to continue working on the projects at home. These responses coupled with her interaction with the facilitators, Jane and Alex, and her friend, Bella, when she is working, we recognised the value of the science enrichment programme that created the space for science to be enacted without limits.

Figure 11

Expressions of Joy and Pride
In the image, Jane leans in to probably give further instructions to Red or elaborate on what Flo instructed. Red leans in as well, giving Jane her undivided attention. Then, Red and Jane are quietly talking and laughing/smiling. In the video, we noticed that throughout the whole interaction, Red is not making eye contact with Jane.

Her eyes are shifting but not meeting Jane’s own eye contact. Next, we see that Red and Jane continue working together to set up the circuit. Red is actively engaged and is focused on the process of setting up the circuit evidenced by her lean-in and concentration. Red’s body posture here is similar to her focus in the windmill lesson we see in the prior section. Jane would give instructions to Red as she worked on setting up the circuit. Red’s focus is still on the task as Jane explained. Again, this is similar to her concentrated focus in the windmill lesson. We infer here that her focus is illustrative of her tenacity in completing tasks.

Once they set up the next task of building the circuit, Red leaned back, clasped her hands, sighed, and smiled. She looked satisfied with the task they just completed. Her clasped hands, straightened back, and look of satisfaction suggest a sense of pride (see van Osch et al., 2018).

Figure 12

*Expressions of emotional entrainment*
Red and Jane both lean in to inspect their handy work (offprint 1). Then, the researcher (first author) tells them to turn on the circuit. Once they turn on the circuit, Red and Jane are smiling (offprint 2). Here Jane seemed to have said ‘mooi’ (nice in Dutch) to Red, who is nodding her head in agreement. Red is smiling (shyly), has that look of satisfaction again. They are both smiling. This act is aligned with Wilmes and Siry (2018) and Wilmes (2021) on emotional entrainment. Red makes eye contact with Jane, which might be her first sustained eye contact with Jane (offprint 3). This sustained eye contact comes after their shared success. We see continued emotional entrainment as the pair share in their success evidenced as they smile and talk (offprint 4).

Figure 13

*Shared moments of joy and pride – emotional effervescence*
This is an excerpt from week 6, which has also been mentioned in an earlier section. Red has been working on making a circuit, and has experienced success with the circuit, and there is continued shared joy post success on getting the bulbs to light up (offprint 1). Red is smiling broadly (Duchenne smile). Here we can see the lights are lit from their circuit. Later Red, still smiling, checks her work (offprint 2) and in the next frame she continues to smile and checks her work again (offprint 3). Red is making eye contact with Jane, and there is a longer sustained eye contact (offprint 4). Red continues to have a look of satisfaction (offprint 5), Red keeps glancing down at her circuit, hands clasped, smiling with that look of satisfaction on her face (offprint 6). These are all evidence of expressions of pride.

Overall, this section highlights that Red’s emotional state, which is aroused while she worked with the facilitators and her friends in the space, was reinforcing and shaping her as an actor in the Figured World of Science. Her emotions experienced on the micro level are helping her to form and negotiate her attachment to the people in Community Roots, the environment the space creates, and the culture of science experienced there. The space or structure affords Red the opportunity to be agentic and to 'push through' to be resilient to move on to the next task as she becomes successful with each goal met. In addition to her
agency, this evidence connects with Bakhtinian’s "space of authoring" (Holland et al., 1998) and underscores that Community Roots is a space for science identity authoring.

**The value of science engagement in out-of-school contexts**

In this section, as already illustrated in the previous sections, the resources are present at the different levels in the micro interactions, at the meso level in the encompassing work of the programme, Community Roots, plus the macro level in disrupting or reinforcing values in science. The interactions and activities cut across the three resources, Material, Relational and Ideational. In addition, illustrated in this section is how three resources are present and informed science enactment at the meso and micro levels that reinforce the figured world of science in the macrostructure. The following is a picture of how the out-of-school space that is Community Roots valorises the experiences of science in comparison to school and home.

**The perception of the science programme versus school science**

In the following excerpt Red explicitly stated that she likes school and her perception of the programme. The importance of ‘liking school’ is salient in the comparison between learning at school and Community Roots which could be indicative of the fact that she is interested in learning.

Red: *It is very different from school. Because at school you learn arithmetic, language, spelling and you just kind of learn something with technology and programming."* (Interview 1)

Red: *I like school too.*

Red: *Yes, because here [they [facilitators/volunteers] explain and help you too. And at school, they explain a little bit and you have to figure it out yourself a little bit.*

(I interview 1)

What the excerpt illustrates is Red’s perception of learning science in the programme. This shows the value of programmes like this for offering help and how facilitators offer to lower the threshold to succeed. This also speaks to how spaces such as Community Roots help to build resilience. She learnt programming and technology in school. Community Roots is different “because at [Community Roots] you are *doing* more”. Also, the act of *doing* links to the time on time allotted to school science versus time in out-of-school science engagement wherein school there is more constraint on how much time can be dedicated to the natural curiosity and wonder of children. Community Roots mediates Red’s access to science. The structures of the classroom or school/education culture may not readily afford this type of exploration, tinkering and ‘doing’ required for young children to develop interest,
motivation, and aptitude towards science. Additionally, Community Roots offers a community by default because children are with their friends working together.

Red: My friends are there too, and I spend a lot of time with them.” (Interview 1)

Interviewer: What did you think about it [Community Roots]?
Red: Well, I thought it was fun and educational.

Kim (Interviewer): Yes? And what did you find educational about it?
Red: “Because I could learn new things like make hovercraft, how to program and stuff.”

Kim (Interviewer): Cool! And how often have you been? Do you know?
Red: “Um, I don't know how often. But quite often. Until...from the beginning until... I don't know anymore.”

Aunt Mary: “Until the day of the corona.”

(Interview 1)

Red found Community Roots fun and educational stating that she learnt new things in Community Roots placing emphasis on learning 'new' things, Red’s impression of Community Roots raises questions for us as informal science education researchers and practitioners: What does Community Roots offer for families? What supports does the programme offer and what is the importance of programmes like Community Roots in OST? Red went every week, which further reinforces the importance of the programme to her.

Interviewer: “So, do you want to tell me what you thought about Community Roots?”
Red: “I thought it was fun and educational because you learned all the new things.”

(Interview 2)

…

Interviewer: Do you think that you learn as much on Community Roots as you do in school?
Red: Ehm...

Red: That's possible because we were talking about something and then that week I had exactly the same topic and then I knew a lot about it right away.

Interviewer: Oh, so you had the same topic in school that we first had at Community Roots?
Red: Yes.

(Interview 2)

In the first interview, she often stated that she learnt many things at Community Roots, liked it and found it educational. In the follow-up interview almost a year later at the
end of the programme, she also shared that she learnt about a topic in the programme that she then learnt about in school. She had prior knowledge because she first learnt about the topic in Community Roots. This acknowledgement further supports evidence that the programme supported children and provided educational opportunities that supported their classroom learning experiences in sciences. Additionally, her answers were confident and consistent with her responses in the first interview. Her consistent responses supported the reliability of her assessment of the programme.

Red could also recall the activities she did in Roots which showed a level of engagement.

Interviewer: “And do you have a favourite day of all days?”
Red: “Um, the one with programming. I liked that the most.”
Interviewer: And what were you supposed to do then? Do you remember that?
Red: I had to program a ball game with scratch. And if you touched the red ball, the game was over and every time you hit a ball with an arrow, you got points and you could set yourself.
Interviewer: ... Do you remember any other experiments you did?
Red: we made a water boat. And it could sail on the water. In the beginning, we had done some kind of experiments with blender bikes. We could blend but on bicycles. And I made a spaghetti tower with marshmallows.
Interviewer: Oh, cool!
Red: And I also made slime there.
Interviewer: Nice! I did that once too.
R: Yes and it was.
(Interview 1)

Red liked the programming the most. She could recall the objective of the game: I had to programme a ball game with Scratch - ‘And if you touched the red ball, the game was over and every time you hit a ball with an arrow, you got points and you could set yourself’. She shows a high level of engagement since she could also recall in detail the main objectives and the sequence of the activities that she participated in, although it was already a month later. Her retelling of the activities also provides another support for the claim that Community Roots as a programme offers the children a space to support scientific practices such as exploration, tinkering and computer programming. Beyond the activities, there is also evidence of learning taking place.
Interviewer: “What do you think you learned the most there [at Community Roots]? Red: “How to work well together and how to make things. Yes, how you can make things.” (Interview 1)

Here in this excerpt from interview 1 “working well together” could mean working well with friends or with facilitators which is evident in the windmill lesson and Squishy Circuits© electric circuit where it was demonstrated how she worked with the facilitator at her table, Alex, and the instructors, Alex and Jane, and her friends, Ariel and Bea (pseudonyms).

Interviewer: Would you like to do something like that later, when you are a bit older? Red: “Yes, if I get it very well and stuff.” (Interview 1)

Here Red explains that gaining knowledge or an understanding is prerequisite to learning and engagement. In addition, this suggests a continued interest/sustained interest on Red’s part that will lead to learning. This is evidence of competence and recognition.

Interviewer: Imagine we can continue with Roots. Is there anything you would like to do that would be fun? Red: Yes


Interviewer: cool! Have you seen that somewhere? Red: What do you mean, I don't really get it.

Interviewer: Sorry, it was a bit unclear question. How did you get that idea? Have you seen that on television? Red: Yes, and that seems pretty cool to me, then I would have one (robot) myself.

Interviewer: Yes, I understand, I also want a robot at home. He could clean my room nicely and stuff. (Interview 2)

This excerpt underscores that Community Roots offers a space for tinkering, robotics, and coding, which are STEM and engineering-focused examples featured in the literature with girls in physics or girls in STEM (Dou et al., 2019). A question raised in the analysis is what other opportunities would Red have outside of Community Roots or Scratch at school to engage in these activities and deepen her interest? The answer to this question is linked to the second interview where Red explains lack of understanding as a barrier to completing science projects at home. She needs more guidance compared to how she has guidance in Roots. An additional argument for spaces like Community Roots that allow guidance on tasks with a
lower threshold to fear of failure. This fear of failure that Red experiences is emphasised by her recount of the fact that she does not want to share her grades with her friends if it is low. She strives to have high grades and wants to be validated and associated with such high performance. On the other hand, we saw in the analysis that she failed multiple times in completing tasks, but this was not met with such negative emotions as her grades in school further solidifying Community Roots might have been a space that offered an environment of trust and care.

There are studies with Black students that share findings that fear of failure in front of peers and supervisors is an obstacle to seeking help (Smith, 2022; McGee & Bentley, 2017) and what Claude M. Steele (1999) terms as stereotype threat—“the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype” (p. 46). There are groups, mainly marginalised in society, who deal with severe negative stereotypes about their abilities. The examples Steele (1999) gave are college women in advanced mathematics and African American in all academic areas in the United States.

A coping mechanism that persons use to assuage the negative psychological effects of stereotype threat is “disidentification” (Steele, 1999). Disidentification is distancing oneself from the identity that is causing psychological pain (Steele, 1999). However, disidentification can be a pyrrhic victory (Fordham, 1988). The high price that the person pays might be giving up a salient part of their identity to achieve success in aligning with the culture of power that is reinforced in the academic environment.

Signithia Fordham (1988) illustrated in the findings that came out in her long-term ethnographic study of a fictional high school, Central High, in the United States, the tension that high-performing Black children encounter in having to deny or downplay their racial identity to reconcile their collective cultural ethos of success with the ethos of their individualistic view of success in their academic programmes. Whereas these academic programmes drove deeper emotional and psychological conflicts for these children, programmes that are community-based in focus, similar to Community Roots, offer the space for children to engage in science without this burdensome barrier to their performance. Moreover, we find that Community Roots nurtured the Relational Identity resource by providing community for the children and their families.

Red’s Aunt Mary invited her friends so that she would not be ‘alone’ at Community Roots. Here this is evidence of the familial support Red has and recognition on the part of her aunt; the recognition especially of the importance of ‘belonging’ having company or being
comfortable in the space.

Aunt Mary: Yeah! I met her friend’s parents. I invited one of her, from no other school, so they could be together. That she doesn’t have to be there alone. And they also enjoy being there. Other friends from the school. But they are not from this school where she goes now, they are from another school from where she used to go… Yes, she really needed it. Because that bond is longer than at the new school.

(Interview 1)

Red lacks bonding with friends at her new school, so Aunt Mary set up a scenario for Red’s friends to be present at Community Roots, thus creating a positive emotional association with Community Roots for Red. The space offered a ‘safe space’ and encouraged exploration and tinkering and the facilitators and friends that helped to create the community encouraged more. We see the enthusiasm and how proud she is of her creations in the programme which is further illustrated in her first interview where she shares that she tells her aunt about what she did in the programme when she returns home. We see a shift when she prefers to be in her room at home as opposed to sharing with her aunt. This is typical in socialisation where the peers are more central to the young adolescents’ daily experiences. Consequently, the programme offers this space with her friends and near-peer facilitators (a group made up mostly of university students). Here her aunt’s encouragement might be eclipsed by the supports and resources present in Community Roots.

Interviewer: “When she came home or did, she talk about it enthusiastically, for example?”

Aunt Mary: “Yes! Yes of course. She was always ... She was a little disappointed when it was over.”

Aunt Mary: Yeah, she really likes it [Community Roots].

(Interview 1)

Red’s Aunt's response is consistent with Red’s assessment of Community Roots that she really liked the programme. There is also evidence of the emotional attachment to the programme when she informs the interviewer that Red was disappointed to see it ended when the programme had been put on pause due to lockdowns after the first wave of the COVID-19 virus and all activities at the community centre were cancelled. Her consistent responses and enthusiasm reinforce the value of community-based science engagement spaces.

**Drawing a parallel in tensions between identities**

In this section, we explore tensions in Red’s identity that are as a result of the society
she is figured into and how she is positioned and is in the process of positioning herself in this world. This tension is likened to the non-belongingness that occurs in science for some groups that do not readily see themselves as part of the world of science. In addition, out of the tension comes a hybrid identity that characterises Red’s experience and can be extrapolated to the experiences of other children like Red.

    Interviewer [00:27:54] [In Dutch]: T asks, let’s say what is your identity? how do you identify yourself? What do you think this means?
    Pause...
    Red [00:28:13] [In Dutch]: I don't really understand the question.
    Interviewer [00:28:16] [In Dutch]: So, do you know how ... let's say what is your identity? Do you know what that is?
    Aunt Mary [00:28:21] Her background.
    Red [00:28:25] Aah...
    Aunt Mary [00:28:28] [In Dutch]: your heritage/background.
    Red [00:28:32] [In Dutch]: I was born in the Netherlands, but my mother is from Sint Martin and my father is from Curacao. Which means Caribbean/Antillean. But I do not know if I am Caribbean.

(Interview 3)

Red’s confusion about the term identity would suggest that in the Dutch context, identity is not discussed or performed in public where the official census has racial and ethnic identity questions, for example. Moreover, it is not common practice to have someone add their heritage to their nationality, for example saying I am Jamaican-American, German American, Puerto Rican or Hawaiian even as a US territory.

    Researcher [00:28:53] So, you identify as your Mom is from St. Martin, your Dad's from Curacao, so you would advise Caribbean and Dutch?
    Red [00:29:01] Mmhm.
    Pause...
    Researcher [00:29:02] Because you said Nederland, I am like at level 0 in Dutch. So, that is how you identify ethnically. How would you identify racially?
    Red [00:29:19] ah mmm...
    Researcher [00:29:26] This is a tough one because they don't talk about this in Dutch, in the Netherlands.

...  
    Red [00:29:39] I don't get the question.
Red [00:30:07] Mmmh [she looks confused] (Interview 3)

Red alludes to the nuances of Caribbean/Antillean complex in the Dutch Caribbean community: Mother from St. Martin, dad from Curaçao which means Caribbean/Antilleans. Her using phrases such as “mmm…” suggest she is thinking and processing the questions. Though Red’s responses suggest she was befuddled by the question about her identity, she does not negate it or affirm her Caribbean identity but rather considered it. In the end, she says I don’t get the question, which we interpret as she does not understand enough to articulate a response. This again supports our claim that she is processing the information since in other responses when she is sure she responds right away. Furthermore, her saying I don’t know is akin to a proverbial shrug, but one in which she cannot quite articulate or reach for that which eludes her. This highlights the tension that is present in her conflicting identities. Yes, the pause suggests a tension in identity-making the development. Adolescents are forming their own identities outside the home and there is a constant tension in the body and mind of the teen of who they are.

Aunt Mary [00:30:29] For her, the question that you are asking could be a bit difficult for her because going to school there and look at her as a Nederlander and then they would not really refer to her as a Caribbean. They will call her "foreigner" or whatever, and most of the time they would call them Antillean because Sint Maarten and Curacao, you have the small Antilles, and you have the big Antilles. Sint Maarten was the three S's, Sint Maarten, Saba, and Sint Eustatius are the small ones. Curacao, Aruba, and Bonaire are the big ones. So, we are called Antilleans. And we from Sint Maarten we call ourselves Caribbean because we are from the Caribbean. So, we will look at ourselves as Caribbean people. Even up here they will call us Antillean. Up here they will call us Antillean, and we Antillean people call ourselves Caribbean people because we are mostly surrounded by Caribbean people. (Interview 3)

Here Aunt Mary explains the nuances of how Red might be perceived as Nederlands (Dutch) in school. She would also not be referred to as Caribbean but rather as a foreigner or Antillian. As Red’s aunt explains, her ethnic/cultural identity is imposed on her, which highlights the added layer of tension for Red in identifying who she is in Dutch society: Is she Nederlands or Antillean/Caribbean? Is she still considered allochtoon, a foreigner, though she is born in the Netherlands to Dutch citizens?

Aunt Mary: I know that my sister did her best and let them know their background,
right? And it is for them to accept because she was younger then she may not have remembered most of everything, but then that's the reason why she has a difficulty in explaining exactly her identity right where she is from and where she is at, because other brothers, they already had that, but not she. She did not have it as yet. And so, I will do my best, but it is for them to accept it. And if they want to, they can. You cannot force them to accept it, you know. So then, um, being as a Caribbean person right, our children, .... Yeah, it is different than up here. And even though if you are surrounded with the Caribbean, because I notice some of us Antilleans, some stay amongst each other, so they maintain their habits and culture from the Caribbean. But then, when you are not surrounded with that culture, and, yes, surrounded with a culture of Holland itself, it is quite different and quite difficult to really maintain that. And my sister, she will give the theoretical part or some of the practical part in raising them, discipline. Yes. But then all the other cultures she will adopt from... Holland. So, they had a kind of a mixture.

(Interview 3)

Red’s posturing illustrates the tension that she has embodied: that is, the assigned positional identities she has been immersed in. These assigned identities are based on ethnicity, gender and social standing without much reflection of the social claims carried with these ascriptions. Red is immersed in an institution that demarcates her identity as Caribbean thus having a migrant background. Yet, Red appears to be unaware of this position that she has been assigned. Her pauses and fill ins or “I don’t know” statements are a testament of this conflict between her ideational identity, how she sees herself and how the world sees her. Red does not claim to be Black, a migrant or Dutch. She does not identify as Black in her response to *how do you identify?* This brings about a connection with Fordham’s (1989/1990) conception of *racelessness*. She (1989/1990) writes about *racelessness* as a strategy for high achieving black students in her famous ethnographic study with Capital High to achieve success and evade the crippling stereotype of Black achievement being low compared to their white counterparts.

Here we want to tie this idea of *racelessness* for Red as a matter of lack of discourse about being Black as an identity in the Dutch parlance. This connection highlights the Figured World of Dutch nationhood/culture and how children like Red are figured (or not) into the cultural identity of *being* Dutch. Moreover, Red states that she does not know her cultural identity if she is. From our interpretations, for Red, her Caribbean identity is one of philosophical admission. She deduces, not claims explicitly, that she is Caribbean. She comes
to this identity in a philosophical awareness: “I think, ergo I am”. She deduces her mother is from St. Maarten and her father is from Curaçao, therefore she is Caribbean.

Another identity resource that is at play in Red’s identity authoring is the relational identity resource. Red’s everyday relational interactions in “doing, imitating and correcting” (Holland et al., 1998) with her extended family and late mother have been crucial in her identity formation and impacted Red’s embodied identity of Caribbean-ness. Furthermore, we see another relational identity resource coming to the fore, that is, one of her hybrid identities as she is encultured in the Figured World of the Caribbean Diasporic Identity. As her Aunt Mary opines, in explaining the culture of Red’s Caribbean heritage and the culture she is now immersed in, that Red would consider herself “will adopt from... Holland [culture].

So, they had a kind of a mixture.” She would pull from both cultures in her identity-making. This hearkens back to Stuart Hall’s point on diaporisation, which is… The Caribbean identity is passed on to younger generation...it is the responsibility of older generation to pass on Caribbean identity evident in words like “I try my best” and “Her mother tried”. Her difficulty in Holland to maintain Caribbean-ness: “She will adopt from Holland...”. Note here that the aunt reinforces Red’s Dutch identity and a hybridisation / assimilation that is present in the culture for those of the Diaspora. Aunt Mary response reveals the tensions at the crux of identity making. The violence that undergirds the simple question: Who are you? Or in the reflexive, Who am I? presumes from the outset that there is a group to which you belong a solidarity to which you cleave, an insider/outsider status that dictates how you are positioned.

The everyday discourse of positioning can be disrupted. In science identity research, science educators have long argued that, as researchers, we have to disrupt present ideas of who is and who can be considered a science person. We have espoused ways to offer alternative frames to dismantle longstanding traditions to achieve this. The resources experienced in Community Roots, cut across all three identity resources, material, relational and ideational, offers ground for a re-imagined position in science identity. The possibility of becoming is nurtured in the space. Red’s trajectory of becoming a nurse is not limited to bedside nursing or midwifery. (Note here that there is nothing wrong with pursuing these professions as we make this point).

The possibility of another frame is available to her. If the desire to be a researcher in nursing education or the health field if she wants. This other frame is evident in her response to the question of whether she would become a scientist or researcher, when she says, “I could be”. The alternative frame is a possibility.
**Discussion**

This study gives us the opportunity to explore acts of science identity negotiation, positioning, and authorship from different cultural and social frames. The study used a bricolage of frameworks to investigate how science is enacted in a community-based science program, drawing on the overarching sociocultural lens of Figured Worlds (Holland et al. 1998) to study science identity framed within Identity Resources (Nasir & Cooks, 2009) and encased in a Caribbean Diasporic narrative.

Additionally, one of the main points in this research is the illustration of the complexities of *becoming* and *being* in science in informal learning contexts. Community Roots and Red’s story offer evidence of an environment that engendered science practices: wondering, tinkering, creativity, and curiosity. Red’s agentic engagement in Roots is an embodied and interactional endeavour, as we see evidence of joy and other positively laden emotions organically cultivated through the resources the programme afforded.

In addition, evidenced in the findings are emotions of joy, pride, curiosity, wonder, and tenacity that gradually build up to resilience. They are positively valenced emotions and joy in science, and more importantly, there is evidence of Black joy in science and emotions in science identity. Author (2022) describes Black Joy as the “freedom, imagination, community and love” (p. 201). Cultivating and centring Black Joy in science, as Author argues, encourages Black learners, in this case, learners from the Caribbean, to develop their creative ideas and explore scientific innovations unashamedly and fearlessly. Centring Black Joy fosters in Black learners a sense of scientific discovery and transformative endeavours from their worldview to be change agents in their spheres of influence (Adams, 2022). Specifically, in Community Roots, Black Joy is present in the ways in which Red comes to *being* in science.

Community Roots as a liminal space acts as a bridge in the ecological systems of learning in formal and informal science learning. This liminal space serves the purpose of ecozones or transitional zones in ecosystems that are rich in biodiversity. Kim Trevathan (2013) describes these zones as liminal zones. The Latin roots of the word liminal means threshold, *limen*. Thus, to be in a liminal space means to be on the threshold, be in an in-between place on the cusp of bursting with life. In her book, *Liminal Zones: Where Lakes End and Rivers*, Trevathan (2013) describes the ecozones of rivers and lakes that place in between stillness and rushing waters as liminal zones.

Liminal zones are a source of life in an ecosystem. Similar to the brackish waters of
estuaries, which are habitats to many fishes, sea creatures and plants, and are beneficial to humans, such community-based programmes as Community Roots, serve the dual role of “being grounded in rich and nurturing relationships, making for meaningful engagement and identity work in science” (Rahm, 2014, p. 396).

Nichole Pinkard (2019) refers to these bridges as connective tissues. Connective tissues are invisible webs that hold communities of learning together and ensure fluid movement across each learning component. Pinkard (2019) argues that they are “essential to ensuring a robust learning ecosystem…and working well for all intended audiences…participants can see choices, patterns for participation, and potential outcomes” (p. 44). Following Pinkard’s (2019) argument, Community Roots, therefore, forms part of the connective tissue that provides support to children and their families to gain access and be supported in engaging in science.

Furthermore, to expand on this position of Community Roots occupying a liminal space, an in-between space, we apply Kris Gutiérrez's (2008) concept of the ‘third space'. In her own conception of the Third Space, Gutiérrez (2008) described “its genesis in observing closely the differences in involvement, participation, and learning of students in classroom instructional activity and noting multiple social spaces with distinctive participation structures and power relations” (p. 152).

The connection for us is that the third space is a process where minoritised students decompartmentalise and mediate spaces, especially White-dominant spaces. The community-based informal science education provides the liminal space in the ecosystem of learning where children are supported--children who do not usually fit into the mould of the dominant narrative of who can do or belongs in science. In these in-between spaces, one might misinterpret quietness for lack of participation or performance where one might not be as 'loud' and takes it for lack of interest.

In attending to these contradictions on the macro level of interpretation, a parallel can be drawn in comparing the performance and competence that is pursued and depicted in science identity studies could likely be rooted in the figured world of science--an ideology of whiteness and power that is embedded in Modern Western Science. Science identity authoring shows up in the form of performance and competence for Red, and children similar to Red, who may not feel that they will pursue science and who are not are science person based on the literature, but who quietly performs and achieves competence and is enacting science practices but 'feel' that they may or may not want to do science (Wades-Jaimes et al., 2021). For these children, it is their resilience and agency that sustains their connection to
Resilience is often argued from a place of leverage: that is, using one's inner strength, *bounce-back-ability* to succeed in science. Resilience serves as the foundation for Black people—refer to the Black experience in respect to settler-colonial and colonial empires—to thrive and survive. As Jennifer Adams (2022) articulated, “in North America and other antiblack colonial and postcolonial contexts, Black pain and Black joy exist in a dialectic where Black joy is resistance, resilience and illumination in the darkness of the violence and pain” (p. 200).

Resilience is built up over time. It is scaffolded, that is, each success or failure is another scaffold to build up one’s resilience over time. Out-of-school contexts offer these spaces where the stakes are low, and support is provided in comparison to the classroom where the structure might be supportive, but the time to slowly build up one's resilience in science or to be a science person might be low or lacking. The analysis presented herein demonstrates how Red’s resilience develops in-the-moment, in a dialectical process with the success she experiences in the open and welcoming space of Community Roots. The successes she experiences push her to continue working on her project. When she fails, her determination to become successful provides the momentum to keep going; each failure and subsequent success propels her forward towards the goal of the project, and her resilience evolves in the process of tinkering and investigating.

Community Roots is a site of cultural brokerage (Martin Dunlop & Ferguson, 2020). In addition, as part of the Diasporic identity, places of cultural brokerage serve Black communities and help to build agency and resilience (McGee & Bentley, 2017; Ferguson & Marin-Dunlop, 2021). As a cultural broker, Community Roots offers a safe space for Red to fail and succeed which reinforced her tenacity to pursue the goal of finishing the activity. This perhaps can be an indicator of the tenacity she has and is further developing—a tenacity which is also useful to pursuing a career in science.

We pause here to highlight two principles that cannot be overlooked when talking about resilience and creating safe spaces. Firstly, as mentioned in the section framing this chapter, there is a dark side to resilience (Mahdiani & Ungar, 2021). The responsibility is laid squarely at the feet of the already oppressed and marginalised groups to cope and navigate spaces that are institutionally corrupted by racist, sexist, ableist and colonial practices in order to be successful. Researchers, Terrell Morton and Tara Nkrumah (2021) counter that promoting resilience as a mechanism to success for Black women in STEM is complying to a white supremacist regime where the marginalised has to persist through the micro-violence
and micro-aggression to come out victorious. Instead, they call for spaces in practice and frameworks in theory that resist and disrupt longstanding systems that propagate injustice.

Secondly, along similar reasoning, the use of the words ‘safe space’ without thinking about the fact that a space is not safe for all involved endorses the inclusion of some groups while simultaneously excluding others. The words often used to note the inclusion of all participants might only ring true for the person who uttered the phrase and saying a space is safe thus does not automatically deem it as such (Alexakos, 2021).

This chapter also highlights the limiting identities placed upon Caribbeans and other people of the African diaspora in similar colonial and settler colonial contexts. It is commonplace for the nursing profession in the United States, United Kingdom, and Canada to be dominated by immigrants, especially those from the Caribbean and South Asia. It could be likely that a career in nursing might be one of the few STEM identities available to students like Red who would be the first generation in the Netherlands. Could this be the case for other advanced countries the Diaspora emigrate to? In light of this question, we also trouble the perception of who is/what is a scientist in its likeness to who is considered a Dutch person in the cultural imaginary of the Dutch population (Wekker, 2016).

We see a similar limit in the imaginary of not just who is or who can become, but what profession falls within the realm of science. Similarly, this argument connects to our previous position on the barriers that stacking and tracking in the Dutch education system, especially children with migrants’ backgrounds who are most affected by these practices. Inherent in this route to pursuing a profession, is the tenacity and resilience that a child will need to harness to be successful in realising their career goal.

In its conceptualization, science identity has the underlying premise of who is considered a scientist predefined. We have to engage with a transdisciplinary focus in science education - how does nursing fit into the field of science for science education researchers? The idea is that there is a demarcation for who can pursue science as opposed to pursuing a profession as a career scientist. For us, this research resists the idea that there is a certain type of person (Wallace, 2018) who should pursue a science profession as well as a certain type of profession that falls within the purviews of science. To this end, we have to expand the boundary of science education for transdisciplinary fields such as the health field.

In addition, as already established, the concept of who is seen as a scientist is prominent in this case study. In the data analysis, Red's ambition to be a nurse and work in the health sciences is not readily seen as that of a scientist in comparison to her brother who wants to be a biologist. Whereas both children need to have a grasp of biology and other
science disciplines to achieve their dream, only one career choice was likened to one of a scientist: that of her brother. However, Red, evidence of her tenacity and own agency, leaves us with a clear message: She likes science, has an interest in science; likes spaces like Roots and wants to be a nurse. Simple.

Looking Ahead: Implications for theory and practice

In expanding the boundaries of informal science education, the concepts of liminality and hybridity have been taken up in the framing and analysis in this chapter. In a supposedly postcolonial world, the in-between-ness represented in hyphenated cultures, for example, being Caribbean-hyphen-American, illustrates the complexity and contradictions within the figured world of Blackness in relation to the figured world of science. For one, one is not born Black, they become Black. In (science) education research identity of Black children, or any other participants are figured into a collective Blackness. However, Blackness is not a monolith (Ibrahim, 2004).

This chapter draws attention to the ambiguities and entanglements present in the experiences of communities from the Black Diaspora, in this case, the Caribbean diaspora: experiences that are perpetually suspended in these hyphenated, in-between worlds with each passing generation. When considering the broader context of power and coloniality in Europe, in the Netherlands more specifically, begs the question of what are the challenges that children with Caribbean Diasporic identities face in science education? Exploring Diasporic identities opens up the discussion about the precarity in treating all children of colour, especially Black children, across different contexts as a collective in multicultural work and research. Doing this without critical reflection could further exclude children whose experiences are marked by liminality and hybridity from the conversations centred around equity and inclusion in science.

In addition to illuminating barriers children of diasporic identities might encounter in science education, employing video data in science identity research aids researchers to 'see' a lot more than what is captured in writing, in say, an interview or observations. It helps to broaden the scope of the multiple ways in which children are enacting their agency and ways of being in out-of-school science contexts. For example, in the section of the findings where we discussed Community Roots as a resource once we coupled the interview data with the video and asked the central question of what else is there? It was evident that the programme offered more to the children. In Red’s case, our analysis shows that her hesitation or her tendency to stop working once she is at home, even with her Aunt Mary’s encouragement and
gentle chiding provides evidence of implicit recognition.

Another example of the importance of using video analysis in examining science identity authoring, is to look at concepts such as resilience being enacted in the moment. In the findings, it was shown how Red was being resilient in her actions as she succeeded and failed repeatedly until she was successful in building the windmill. Interviews were the tools used to explore the experiences of Black women in STEM in science education literature. While adults are able to articulate in detail their stories and acts of being resilient, it might be more difficult for young children to express themselves in discussing these concepts in an interview. In this research, however, we used video to help us in demonstrating Red’s resilience that is under construction. The tenacity she harnessed to succeed is a harbinger of the inner strength that will be needed to succeed in pursuing her nursing education.

Although there are benefits to using video data in science identity research, there are challenges in presenting two-dimensional representations of the findings. Though a picture might say a thousand words, similar to interviews, they do not capture actions such the emphatic pauses and sighs which also afford a deeper analysis and interpretation of the participants’ stories.

Another implication of this chapter is the role of the extended family--other members of the family who are caregivers other than the nuclear family- in out-of-school learning and shaping of children’s science identity. Red’s maternal Aunt and Uncle by marriage were significant in mediating her involvement in Community Roots. Her aunt had signed her up for the programme and she was driven to or picked up from the centre by either her aunt or uncle. These simple actions are evidence of implicit recognition of Red’s science identity authoring. Moreover, in the resilience literature cited earlier in this paper, (Morton & Parsons, 2018; Ferguson & Martin-Dunlop, 2021; McGee & Bentley, 2017) parents were reported to be heavily involved in nurturing and encouraging the participants of the study science pathways. On the flip side, our data analysis showed it was the extended family that was the support for Red’s science engagement. An outcome of highlighting different family structures in informal science education research, demonstrates how children like Red have the care and support of their extended family members.

In practice, it is essential to develop programmes that provide support for children in their local environments with community members. The importance of these community-based programmes rests in the need for children to explore their interest in science in an environment that this supportive and caring. It is evident in the case of Red and other studies (Wade-Jaimes et al., 2021; Chappell & Varelas, 2021; King & Pringle, 2018) that children
will develop and exercise agency in pursuing their interest in science and likely a science career.

Community programmes can serve as a bridge to families who are in the liminal spaces, and the findings of this chapter underscore the value of an encouraging community-based approach to out-of-school science education/informal science education. This approach engages families especially those from diasporic, immigrant, and/or refugee communities where the community, or rather being part of a community is a tool for survival, identity and success in their home away from home.

**Critical reflections**

The assumption that larger sample sizes and more representation make for more rigorous studies and more generalisable places one’s research at risk of missing sight of the fact that smaller samples can also inform policy-making and educational practices. In fact, there are limitations on how much one can generalise when it comes to large sample sizes (Ercikan & Roth, 2014). Doing and learning from research involves searching for patterns and contradictions. The knowledge that surfaces is then reflected upon in conversation within the community whether through text or in practice (Tobin, 2009). Moreover, it is the reflexivity embedded in research practices that generates rigour in qualitative research and its application.

The “axiological transparency and critical reflexivity (Alexakos, 2015a, p. 38) are central to any research undertaken and are especially crucial in qualitative work. The axiological shift in our research is a true reflection of our experiences as researchers and the ethical considerations of our participants. Reflexivity is the cornerstone of our research and is a tool that allows us to mitigate our own subjectivities in our empirical pursuits. Therefore, we cannot end this chapter without reflecting on the ethics of the study.

The question ‘Who am I?’ in the introduction of this chapter can be a jarring question. Inherent within this question lies a violence that spans centuries. The question "Who are you?" is not asking for your name, rather the question is asking about your ancestral lineage in certain communities (Delpit, 2016). In some African and other Old-World cultures, the appropriate answer to such a question would be to state the village where your family is from and your maternal surname, your matrilineal descent (M. de Witte, lecture, March 4, 2019). Sadly, settler-colonial and plantation societies like the Caribbean, are hard-pressed to trace our matrilineal ancestry. Yet, science identity researchers engage with versions of the question who you are.
Therefore, similar to our earlier mention of the colonial gaze, we are aware that even as researchers committed to equity, inclusion and social justice in science education research, our study raises the question of the researcher’s gaze: that is, how as qualitative researchers do we impose our own positionality onto our participants. Turning the gaze inward, we see where we have to take care of how much our own identities are imposed onto our participants or co-researchers.

Doing research in a context where you are not familiar with values, cultural mores, norms, and language brings about the importance of drawing on parallels and comparisons based on your own positionality. For example, throughout the course of the research project and earlier analysis, the first author, who identifies as AfroCaribbean, in dialogue with others and in writing, would often refer to Red as A, too. Though over time as the first author engaged in the reflective process her own experiences with the data and understanding of the context changed and the use of the term, ‘AfroCaribbean’ did not seem appropriate for Red. In the findings, Red, who has conflicts ascribing to an identity, within the larger context of Dutch society is considered allochtoon, foreigner. As researchers, especially the first author, trusting the process and ethics of reflexivity, grappled with the notion that we, too, could be imposing onto Red an identity.

Red’s narrative gave us the opportunity to negotiate interpretations of her experiences and use the frames of event-oriented inquiry to guide further science identity research and its practical applications (Mattingly, 2007). In looking ahead, we underscore our position and commitment, as authors, to forge and (re)-imagine the many possibilities to future research in science identity work grounded in equity, social justice, and increased access to science.
Chapter 5: Exploring hybrid spaces: Children’s identity authoring in a community-based STEAM-enriched programme

Abstract

In this chapter, we highlight how a community-based STEAM-enriched programme offers insight into how resources, as affordances, were leveraged in moment-to-moment interactions across hybrid spaces of virtual and in-person learning environments. We consider Figured Worlds and Identity Resources as the theoretical and analytical framing of this study. The primary data collected from the study included interviews and videos of children engaging in science activities at home over Zoom. The analysis combined open coding and focused-coding strategies based on the analytical frameworks of Figured Worlds and Identity Resources. The findings showed that children use resources provided in the out-of-school programme to support theirs and their families’ science enactment in their everyday lives. Additionally, their experience with engaging in science activities in the programme and at home with their families supported their future selves as science persons. It also underscored the importance of having spaces in informal science education for families to explore science safely.

*Keywords*: informal science, hybrid spaces, science identity
Exploring hybrid spaces: Children’s identity authoring in a community-based STEAM-enriched programme

With the onset of the coronavirus (COVID-19) and consequent global pandemic in 2020, educational institutions in over 190 countries had to cease face-to-face learning and accommodate alternative measures for distance and remote learning (UNESCO, 2020). Virtual or hybrid education became the order of the day: educators and educational institutions at all levels had to shift from in-person learning environments to remote learning. Informal education was not spared from these changes, which meant informal educators also had to transition to remote learning by engaging with the children and their families with a virtual or a hybrid model. In this study, we conceptualise and explore the idea of hybridity beyond the modalities of learning to look at how children navigate the different spaces in their everyday experiences. A learning environment that is between home and school and both online and in-person creates a hybrid space.

This chapter aims to explore family involvement, science teaching and learning for children in out-of-school science learning contexts, especially during a pandemic and remote learning. The overall aim is to explore how young children come to form, negotiate, and author their science identities in a hybrid community-based STEAM-enriched community-based programme. STEAM stands for Science, Technology, Engineering, the Arts and Mathematics. The programme took place on Saturday mornings at a community centre in the neighbourhood where most of the participants in the study lived. From here on out, the programme will be referred to as “Community Roots”.

STEAM, transdisciplinary, hybrid space

This study is situated in a community-based programme offering a Science, Technology, Environment/Engineering, Arts and Mathematics (STEAM)-enriched curriculum that took a transdisciplinary approach to integrate the different disciplines. STEAM is a form of social practice that has also been adopted in informal science education (Guyotte et al., 2014). As the literature points out, over the past 15 years, STEAM has risen as an approach to “improving student engagement, creativity, innovation, and problem-solving skills” (Perignat & Buonincontro, 2019, p. 31). These skills were also highlighted in an integrative review study of 44 articles by Perignat and Buonincontro (2019). The researchers found, among other assertions, that 50% of the reviewed articles asserted STEAM built students’ creativity and engaged them in STEM learning. In a special issue in the Arts Education Policy Review, Tracie Costantino (2018) argued that the transdisciplinary
approach of STEAM is an effective way to capitalise on the values that are inherent to the relationship between the arts and STEM disciplines. In essence, the transdisciplinary nature of STEAM promotes creativity and hybridity in community-based spaces.

In their paper, Strong et al. (2016) borrowed from Basarab Nicolescu’s (2005) definition of transdisciplinarity, which purported that the fundamentals of the approach are what exists across, within, and beyond disciplines; intending to understand the complexity of the world and unify different knowledges. To this end, Strong et al. (2016) generated Crit-Trans heuristics that grappled with the notion that all learners come with varied knowledge and experiences and can come together to collaborate and collectively (re)construct [science] teaching and learning. The Crit-Trans approach applied to science education is a way of cultivating “learning environments that foster creative transdisciplinary agency around knowledge production and enactment” (p. 228). When we apply this idea to Community Roots, we see that the transdisciplinary nature of STEAM supported creativity and also disrupted the long-held belief of what science should look like and how it should be enacted.

The spaces in between and across disciplines within the STEAM framework spaces of ecological richness: that is, there are interactions and activities taking place in between these spaces that promote learning. Some science education researchers refer to this space across disciplines as the third space (Gutiérrez, Baquedano-López & Tejeda, 1999; Moje at al., 2004). As Strong et al. (2016) interpreted Elizabeth Birr Moje et al.’s (2004) conceptualisation of the third space where students’ knowledge outside of the classroom is integrated into the learning that occurs within the teaching space. Gutiérrez and colleagues (1999) describe third spaces as transformative sites of “collaboration and learning”, and these hybrid zones exist at multiple and complex levels within “learning environments” (Gutiérrez, Baquedano-López & Tejeda, 1999, p. 288). The third space is also known as the hybrid space, the term we will use in this chapter. Hybrid spaces are used instead of third space because we want to highlight the physical and metaphorical spaces that the programme reaches in the virtual and physical worlds and the spaces across these spaces.

Hybrid spaces and affordances

These hybrid spaces are not disparate entities; they are porous and similar to the interstitial fluids surrounding the semi-permeable membranes of eukaryotic cells. Hussénius et al. (2016) use an analytical framework of interstitial spaces to understand identities. They define interstitial spaces as the imaginary spaces between and with boundaries; they can be within and between disciplines. They are the spaces where new knowledge is gained and
utilised to challenge existing cultures. These interstitial spaces are what we similarly term as hybrid spaces. Hybrid spaces are rich ecological zones that allow the flow of activities and interactions, while also allowing learning from one space to another to take place. Leaning toward Engeström’s (cited by Gutiérrez et al., 1999) activity theory, these hybrid zones created in one learning environment extend into another, where the activity gets reorganised and yields new grounds for continued learning (Gutiérrez et al., 1999). In addition, these activities, interactions, and learning flows can also be described as affordances. These are the affordances that are leveraged by children and their families in informal science learning spaces such as Community Roots. Adams and Gupta (2015) teach that affordances are objects or environments: that is, they are resources that are leveraged to transform into a “new way of learning, interacting or mediating learning” with objects or activities available (p. 122).

In addition, Adams and Gupta (2015) argue that the affordances, which are resources, are held within fields— “sites of cultural production and transformation” (p. 124). These porous boundaries allow crossover science engagement in one field to be re-enacted in another. These perspectives of Gutiérrez et al.’s (1999) transformative activities in third spaces, along with Adams and Gupta’s (2015) affordances in informal science learning extend to the hybrid spaces created in Community Roots, as these ecological zones of learning act as bridges between the figured worlds of home and the school space, enabling students to develop an all-round approach in the enactment of science.

The following section outlines the theoretical and analytical frameworks of Figured Worlds and Identity Resources used in this chapter. Subsequently, a literature review situates this chapter in informal science education.

**Twists and twine of figured worlds and identity resources**

In this chapter, we adopt a bricolage that nests identity resources within the construct of figured worlds (see figure 1). Many science education researchers have used Figured Worlds to study the development of science identity with children and adults, university students, and pre-and in-service teachers in both formal and informal science educational settings (Avraamidou, 2019b; Calabrese Barton et al., 2013; Gonsalves et al., 2013; Rahm et al., 2022). Figured Worlds are imaginative and physical spheres that members are recruited into, where they enact practices and become embodied in their roles in this world (Holland et al., 1998). At the same time, science could arguably be considered as a ‘world’ in which activities and practices are “…historically contingent, socially enacted, culturally constructed…” (p. 7). The discourse, practices and social conventions that characterise the
field have been constructed and situated over time within particular contexts. These constructions may be the practices within the discipline; the discourses around science; cultural and social norms of science; and how they are discussed and enacted in everyday life. For us, this means that science is a field that creates group membership in which one has to engage in activities and practices to become part of this world. Simply, individuals are socialised into the world of science (Brown, 2004; Vincent-Ruz & Schunn, 2015). Therefore, for this chapter, we frame science as a Figured World because it is a construct that affords us the lens through which to interpret children’s border crossing (Aikenhead & Jegede, 1999) and science engagement in different spaces—mainly their homes, the science programme, and to a lesser degree, their school.

With the onset of the COVID-19 virus and the subsequent global pandemic, we saw families and children being homebound and having to work and study remotely, which led to many growth areas and challenges. Previously, more discrete worlds were blurred and overlapped in demanding, rich, and, simultaneously, catastrophic ways. Figured Worlds allow us to view how children negotiated the different spaces and worlds they navigated from the vantage point of an out-of-school programme.

These various Figured Worlds are what we conceptualise as resources. According to social psychologists Stets and Cast (2007), resources must sustain and improve the interactions and the individuals connected to them. Stets and Cast (2007) go on to argue that resources support and sustain an individual’s identity and self in the contexts in which they are used. Additionally, resources are not static, but dynamic and fluid. They can either be used in the moment, or their uses will come into play in the future (Stets & Cast, 2007). This concept of resources is a crucial component in this chapter’s analytical framework since we use identity resources to serve as an added analytical tool to layer the figured world.

We used Nasir and Cooks’ (2009) construct of identity resources to examine the resources that children were afforded in the programme. There are three types of identity resources according to Nasir and Cooks (2009): material, relational, and ideational. In this framework, material resources are regarded as tangible artefacts; relational resources refer to the interpersonal ties between individuals in and out of a specific setting; and ideational resources are perceptions of oneself and one’s relationship to a place and the world (Nasir & Cooks, 2009). Figure 1 illustrates the connection and overlap between the Figured Worlds of home, Community Roots, and school—nestled within the three identity resources.
Figure 13

Figured Worlds and Identity Resources

Note. Shows the overlap of Figured Worlds and Identity Resources between home, Community Roots and School.

Let us consider the ways in which identity resources connect to the Figured World of science. The materiality of Figured Worlds considers the actors within the space and how they employ tools or artefacts to open up learning and embodiment of the identity one is authoring. As Holland et al. (1998) argue, artefacts, the tools employed in the Figured Worlds, “are evoked, collectively developed, individually learned, and made socially and personally powerful” (p. 61). These artefacts are considered cultural in practice, and they aid in authoring identities. Going back to the previous argument of how resources sustain the person and social interactions, and how those sustained interactions influence a person's identity and self; similarly, social interactions are essential in the authoring of their identities, which lends itself to the interaction-driven construct of identity resources, that is, the relationality of resources. The individual and collective nature afford this relational component of identity authoring. Through the collective use of the practices, one comes to embody (and, therefore, impose on oneself and others') identities through interaction with others and the materials used.

Science identity authoring and hybrid spaces

In this chapter, we are interested in how children author their science identities and, more pointedly, how they author themselves in a hybrid community-based STEAM-enriched programme. It is also important to note that we study identity from a sociocultural perspective. The following section outlines how we conceptualise identity and, later, it shows
how identity is used to construct science identity authoring.

Identity theorists have defined identity from the individual's perspective and then from the social aspect. Social psychologists Abrams and Hogg (1988) reasoned that identity and group membership, which they termed ‘group belongingness’, is inseparable from an individual’s sense of self and conception of who they are (p. 7). Here they specifically refer to social identity and discuss that an individual ascribes descriptions to themselves based on the characteristics of the social group to which they belong. Thus, on the one hand, individuals’ author their identities when they see themselves as part of a group. On the other hand, people not only see themselves as part of the group, but also in opposition to it. Thus, they might place themselves as part of the ingroup or out-group with respect to a particular group.

Moreover, Shanahan (2009) posits that generally, our identities are co-created and cannot be separated from the context and relationships in which individuals are situated. This tells us that identity is relational and contextual in construction in situ. In addition, psychologists Ashmore and Jussim (1997) argue that understanding the self and identity is “crucial to making sense of the thoughts, feelings, and behaviors of individuals…” (p. 11).

Identity, therefore, becomes a tool to help researchers understand the self and others in particular settings. Hence, science education researchers have turned to identity to understand individuals’ motivation, interest in and pursuit of science (Shanahan, 2009). A salient theoretical framing of identity is that identity is constantly in flux and negotiation, context-bound, and developed within interactions (Pozzer & Jackson, 2015). Furthermore, identity is salient in fostering children’s interest in pursuing STEM-related careers (Chapman et al., 2020). Even more so, since children develop implicit biases associated with the STEM fields early on in their lives (Corbet & Hill, 2015), aligning activities in informal science learning with their interests helps them lean towards the field. Therefore, science identity undergirds this chapter as we investigate children’s science identity authoring in their enactment of science.

Calabrese Barton and colleagues (2013) argue that individual’s author their identities over time and space in what they refer to as identity work. Identity work is described as a “dialectical tension between the work that individuals do and how that work is taken up over time” (Calabrese Barton et al., 2013, p. 38). In that, the resources—the actions, norms, and relationships—are leveraged in moments and the spaces they inhabit to take on these possible identities in their Figured Worlds. When individuals put in the effort to do identity work, this work is known as agency. Adams and Gupta (2015) argue that agency and identity are
dialectical and “develop interdependently” (p.124). Agency, the process of actively engaging with and transforming the affordances, i.e., resources, within the spaces (Adams & Gupta, 2015), allows for the enactment of science practices, thereby negotiating and authoring one’s science identity.

We opt to use identity authoring because it captures how an individual positions themselves and the agency, they cultivate to work on developing their science identity at particular moments across time and space (Calabrese Barton et al., 2013). Calabrese Barton et al. forwarded this construct in a longitudinal study comprising four US cities in the Midwest, on the East Coast, and on an island in the Pacific Ocean. Their research focused on two case studies of middle school girls' nondominant groups and their engagement with identity work in science across three years (sixth to eighth grade) in school, science club, and home. The girls’ engagement across time and space came to inform Calabrese Barton and colleagues about their future science selves and their shifting science identities. Similarly, this case study has informed the research in this chapter on how children’s engagement in science not only directs their interest in science in the present but also motivates them to pursue science and see themselves as someone likely to pursue science in the future.

As opposed to Calabrese Barton et al.’s (2013) study, which was focused on a longitudinal stretch of linear movement across space and time during a three-year study, in this chapter we look at identity authoring as captured in snapshots of actions taken in the hybrid spaces in specific moments of the programme Community Roots. These snapshots of identity authoring are taken in hybrid spaces of semi-melding of boundaries across the virtual video platforms when they are home, and in the informal science learning environment of Community Roots.

**Hybrid spaces across contexts**

Burke and Navas Iannini (2021) illustrate that the intersection between informal science contexts and the home is a space where “active and passive processes involved in identity construction overlap” (p. 26). The researchers conducted an exploratory study in the East-Central metropolitan area of Canada, examining children's science club descriptions of their emotional engagement with science. The children's descriptions were coupled with the club staff and leaders to provide an avenue to explore the forms of science identity work being nurtured in these club settings.

The emotional engagement involved children's accounts of their interests and attitudes as they described their relationship with and involvement in science education. One of the
main findings of their study highlights that the home realm supports and coordinates the interconnectedness of the different science engagement sites in which the children were involved. This evidence strongly connects informal science education settings and the home. It underscores the importance of familial engagement and community-based settings in science learning. Moreover, Burke and Navas Iannini (2021) argue that community-based science programmes offer children a sense of ownership. When we transfer this idea to Community Roots, we can surmise that the children’s ownership over the programme might elicit an emotional attachment within their lives and drive their agency over their science enactment.

Wades-Jaimes (2021) and her colleagues did a qualitative study that featured three Black girls in an afterschool STEM club for middle school girls. Their study highlighted the complex role of informal science or STEM spaces in Black girls’ identity development. They reported that the research context, called STEM girls, operated in dual spaces: a physical and ideological space. The afterschool meeting location, separate from the formal school setting, was a physical representation of privileging and valuing the girls’ experiences and perspectives in the ideological space. Though Wades-Jaimes et al. (2021) described these spaces as counter spaces in their study, they represented hybrid spaces rich in science identity authoring. We argue that spaces offer up possibilities for identity authoring in moments of agency that are not impeded by physical or metaphorical boundaries.

On the contrary, in their study, Wades-Jaimes et al. (2021) discussed that the identity work in the informal space had a limited impact outside of this space. That is, while the participants referenced actions from the informal space, these actions did not drive their identity development and did not cross contexts into the formal space of their school. The authors asserted that in similar studies conducted by other researchers, such as Rahm and Gonsalves (2012), the informal science learning space does not “provide access to non-traditional resources, including ways of knowing and doing science from the [children’s] homes, families, and communities” (p. 19). Here we argue that community-based informal science spaces such as Community Roots are the bridge that connects the children’s science engaging and enacting with their families in their homes and their communities. The literature is sparse on how community-based programmes benefit the science engagement and how they act as bridges for informal science education in the Netherlands which defines the context of this study (author, 2022; Heeg et al., 2022). Hence, this chapter satisfies this lack in research and adds to the knowledge base of informal science education.

Additionally, these hybrid spaces are valuable in exploring and supporting children’s
science identity authoring. Therefore, the research question explored in this study is the following: how do children enact science in hybrid spaces in a community-based STEAM-enriched programme? And, in turn, how do children author their science identities through these enactments? These questions are important because of their potential insights to design and carry out hybrid programmes that connect across the Figured Worlds of the home, community-based informal science learning spaces and the school. Hence, Community Roots is the hybrid space between the Figured Worlds of home and school that the children and families occupy.

Methods

The study follows a critical ethnographic case study design. Critical ethnography examines “social inequalities to work toward social change” (Carspecken, 1996, p. 3). Ethnographic research, as is customary, incorporates participants' examination of social issues and advocacy without the goal of achieving a measurable consequence or intervention (Alexakos, 2015).

It is a methodology concerned with the “nature of the social structure, power, culture and human agency” (p. 3) in people’s lived experiences in a particular context. This research approach allows for and welcomes diverse realities in interpretations of patterns and themes that emerge from the data (Alexakos, 2015). Similarly, case studies are designed to illuminate everyday life's social and cultural realities, and they use observations, interviews, and documentation from various sources to accomplish so (Hamel et al., 1993). Therefore, in coupling the two methodologies, an ethnographic case study provides a rich and in-depth analysis of the children and their families in their various settings: that is, their homes, Community Roots, and to an extent, their schools. Therefore, the “particularity and complexity” (Stake, 1995, xi) of the cases will generate findings that will add to the knowledge base on how children navigate their diverse contexts in science teaching and learning.

The cases were analysed by a collective to track the patterns and contradictions across the data sets. The trustworthiness and credibility of the study were established through peer and expert checking, thick descriptions, and data triangulation (Stake, 1995). It is triangulated with data from participant interviews with children and parents, research reflections and video data.
Context and programme

Situated in one of the northern provinces of the Netherlands, the programme’s curriculum is informed by asset-based pedagogies, namely culturally relevant and sustaining pedagogy (CR-SP), and is centred around STEAM: that is, science, technology, engineering, environment, the arts, and mathematics.

The programme offered a space for children and their families to come together to interrogate issues in their communities so that they could respond with a call to action. The project aimed to create and invite experiences of the families that attend, the scientists who come in to share their life histories and the volunteers who share their expertise each week. The programme builds on the community, with parents, instructors, and volunteers gathering weekly to embark on an activity together. We also included a Meet-the-Scientist section of the project where children were introduced to scientists from various fields: astronomy, physics, pharmacology, and art psychology.

Participants

We had children whose ages ranged from 6 to 12 joining and completing the programme, since younger siblings and friends joined their older siblings and friends. There were 25 families in the programme cut across the socioeconomic ladder, with a variety of migrant and cultural backgrounds. They were recruited through various channels, including the four local primary schools, a longstanding resident, an online newspaper, a parent group, the community centre's Facebook page, and word of mouth. We also emailed four neighbourhood primary school administrators. Then, the primary researcher also visited the same four schools to canvass and hand out flyers to parents to advertise the programme: some families who ended up in the programme had seen the flyers at their children’s schools. Additionally, the community centre distributed and posted flyers within the building and put the flyer and details about the event on their Facebook page. A notification was also published in a Facebook parent group and an online neighbourhood circular. Furthermore, some Caribbean families were contacted personally through a community member who was well connected to and recognised within the Dutch Caribbean community. Similarly, some families joined through word-of-mouth when some of the children and their families invited their friends to join the programme once they started attending.

The six families that are part of this study were part of the programme from the beginning (see table 1). They completed most of the activities both in the programme and at
home. They were chosen because they were consistent in their attendance, being present for a minimum of three-quarters of the 20 sessions, and their time in the programme.

**Table 4**

*Descriptions of children’s cases and their families at the time of the study (all the names are pseudonyms)*

<table>
<thead>
<tr>
<th>Participants</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mae</td>
<td>Mae was nine years old. Her mother, Loretta, and her father, Ansel, would accompany her to Community Roots at the beginning of the programme. However, they eventually would drop her off and pick her up afterwards. Mae loves to draw and did all the tasks assigned. She is very detailed in her drawings and writing tasks. She did not join the online component of the learning as she preferred to attend in person. Mae’s parents are both Dutch. They have an accountancy company for small/middle retail (mkb ondernemers). Ansel is an accountant/tax advisor (boekhouder/belasting adviseur), and Loretta is currently a stay-at-home mom. Her last job was school administrator at the international student office of the Hanzehogeschool, where she helped students with administrative tasks such as applying for a visa, housing, doctor, insurance, finances, etc.</td>
</tr>
<tr>
<td>Red</td>
<td>Red was twelve years old. She showed high interest and earnestness in the programme and attended all the sessions online and in person. Her aunts, Mary and Carla, who are her guardians, accompanied her twice to the programme. The other times, either her Aunt Mary or her uncle—her aunt’s husband—dropped her off and picked her up. She and her Aunt Mary invited two of her friends to join the programme in the second week, and by the fifth week, she asked another friend. Red swims and attends swim sessions weekly. She loves spending her free time with friends and on her phone. Her Aunt Mary, Aunt Carla and her parents are from the Dutch Caribbean. Her Aunt Mary is a business administrator, her Aunt Carla is a nursing assistant, and her late mother was a nurse practitioner. Her uncle is Dutch and is a building contractor.</td>
</tr>
<tr>
<td>Mel and Rina</td>
<td>Mel and her sister Rina joined the programme when they were eight and six</td>
</tr>
</tbody>
</table>
Rina and her sister, Rina, years old, respectively. Their mother, Kelly, and their dad, Billy, would take turns accompanying the girls to the programme. Kelly and Billy are both Dutch. Kelly is a special education teaching assistant, working mainly with students who have a language development disorder and/or hearing impairment, and are on the autism spectrum. Billy is a truck driver, who supplies building materials to other company locations.

At the beginning of the programme in February, only Mel, the older sister, attended due to the age advertised for the programme, which was eight to thirteen years old. Her sister Rina joined afterwards. Both girls missed three out of the 20 sessions.

Mel is a strong swimmer who earned a Junior Redder 1 certificate, meaning she can be a rescuer. In the presentation of their joint experiment, which entailed testing the turbidity of the canal, Mel reported that she loves science and likes to read, count, and play tag with her friends. Rina loves animals—she is very fond of her cats and dog. Rina reported in her presentation that she loves tinkering, Just Dance (a video game series) and spending time together on the hammock with her friends.

Thom was nine years old. He started the programme in the fourth week and attended all the sessions online and in person afterwards. He was accompanied by his mother, Carolyn or his father, Michiel, to the sessions. His parents are both Dutch. Carolyn is a general physician and Michiel works in IT as a software tester.

Thom loves to build things, do experiments, and demolish and upcycle trashable materials, specifically electrical appliances, as explained by his mom. For example, he likes to disassemble and rebuild things. In his own words, he enjoys playing with friends the sports that sometimes are in sportinstuif. It is organised every Wednesday from herfstvakantie (fall break) till voorjaarsvakantie (spring break). (Instuif is an old-fashioned Dutch word meaning you can come as you please, without registering, et cetera.). He is in a programme similar to Community Roots in his school, where they tinker and programme things. It is a selective programme for students interested in this area. His little sister, Mica, attended Community Roots once.

Marc was nine years old. His mother, Celine, accompanied him to the
programme. Celine was introduced to Community Roots by Carolyn and joined the fourth session when we did the Windmill lesson. Marc attended all the sessions afterwards. He and Thom are part of the same selective programme at school. Marc loves everything related to Harry Potter and likes to code, do robotics, experiments, and research history and how things work. Celine is Dutch and works in the service industry and her partner, Marc’s father, is Chilean and a computer programmer.

Dylan, Dylan is eight, and his brothers Shaun and Riley are six and five, respectively (at the time of the programme). Natalia, their mother, accompanied them to the programme. They were absent only four times. They live in a town farther from the one where the programme was hosted, and in the beginning, they were sometimes dropped off and picked up by their aunt or uncle, who lived closer. Natalia is from the Dutch Caribbean and is a secondary teacher in Practical Education. Her partner, the boys’ father is also from the Caribbean and is a factory worker in an Aluminium factory.

Position and responsibilities of the authors in the study

In critical ethnographic research, participant observation (Yin, 2003; Spradley, 1980) is used to collect data from the field while participating in activities and observing interactions among individuals within the study environment. According to Spradley (1980), ethnographers do not simply observe activities, but also participate in them to obtain a sense of the occurrences made and enacted by participants and to document our interpretation of what we noticed.

Written consent was obtained from the parents or guardians of the children to support the ethical considerations in the study. The researchers ensured that the identity of the participants remained confidential, and pseudonyms were used for all participants and their families when discussing data (Taquette & Borges da Matta Souza, 2022). In addition, the researchers also ensured that they engaged in reflexivity and took preventive actions to ensure that they adhered to the ethical aspects of the study (Taquette & Borges da Matta Souza, 2022).

With the exception of the second author who was mostly involved with the research, most of the research team members, who are also co-authors, played different roles to varying
degrees in the programme's co-creation, implementation, execution and research. The first author took the role of the primary researcher as they took the lead in all facets of setting up and carrying out the programme. The other co-authors were involved in developing the framework and data collection tools used in the study. To do this, we met biweekly to discuss the programme's story and the study's research components and generate the future direction of analysis and research focus. These meetings allowed us to reflect on the theoretical and methodological process of the research, as well as of the emerging and ongoing findings (Merriam & Tisdell, 2016).

There were several salient moments in these meetings that steered the progress of the research. In one such pivotal point of the study, as the programme had to switch to online sessions, the authors discussed the research progress and how to go forward. During the meeting, the second author raised compelling wonderings and questions about online learning and equity around informal science education and learning ecologies. Some of the wonderings and concerns the researchers considered include: (a) loss of community, and whether there are learning losses when going virtual, (b) learning in non-dominant culture, how is learning happening in the home and ownership over this space, (c) how do you come to identify with or develop a type of identity in this context, e.g., not being in touch with emotions? d). how do you bring in the sense of belonging and ‘feeling’ but focus on the do-it-yourself (DIY) experiments they produce? These memos allowed for ongoing preliminary data analysis and steered the study's direction (Strauss & Corbin, 2008).

It should be noted that due to the geographic location and 10-hour time difference, the second author could not participate in the sessions. However, all the authors took part in some of the lessons and activities with the families and children and did some of the data collection. As the lead researcher and author, from the idea conception to programme inception and execution of the project, I had the dual role of an insider and outsider throughout every component of the study. I was responsible for the conceptualisation and design of the curriculum; implementation of the activities; everyday tasks and decision-making; communication with the volunteers, the director of the cultural centre, scientists, and families. I played an active role in recruiting families and volunteers, and I worked with collaborators on planning the curriculum, preparing materials, teaching alongside facilitators, participants, and co-participants. In addition, I directly engaged with the children and their families.

Merriam and Tisdell (2016) argue that researchers need to include their positionalities, which includes their dispositions, beliefs, and life experiences in relation to
the study to uphold the integrity of the study. Thus, a researcher’s position should be
discussed to illustrate how it affects the research process (Merriam & Tisdell, 2016). In order
to ensure that the researchers’ biases, assumptions, beliefs and life experiences are explained,
I, as the primary and lead researcher, explain my position in this study: on the one hand, I am
not from the context of the study, and on the other hand, I have had 10+ years of experience
working with children from primary through postsecondary education in different cities and
countries. Of those 10 years, I taught science at a middle school for 5 years. I hold a
bachelor’s degrees in biology and education and a master’s in science education. Therefore,
my experiences growing up in the English Caribbean, then emigrating to the United States
and working in three different cities and two different states on the East and West coasts of
the US before relocating to the Netherlands have given me a wider understanding of working
in different contexts and collaborating with a diverse group of individuals.

Data sources

The study’s findings emerged from the core and peripheral data collected (Holliday,
2007). The core data sources included two sets of 30- to 60-minute semi-structured
interviews and artefacts, including video and PowerPoint presentations, drawings, and
pictures that the children produced. Two of the families did only one of the two interviews.
All the others did two sets of interviews. The peripheral data came from video and audio
recordings, text, and emails between the first author and families. The interviews were
conducted with the child and a family member; most of the time, it was the child’s mother.

The first interviews were conducted by research assistants who were master's students
and used the data as part of their master’s thesis. They were trained to do the interviews
before completing the task. This first set of interviews was carried out in the spring of 2020,
five weeks after the programme started, and as it had to go on pause due to the government's
instituted restrictions in response to the COVID-19 pandemic. The interviews were done over
the phone and audio recorded. We call this phase one as we resumed the study once the
restrictions were lifted in the fall of 2020. The main aim of these spring interviews was to get
an overall picture of how the children viewed CR and what they would like to see in the
second phase of the programme once the government lifted the restrictions. For example,
some of the questions included:(a) “What was it like for you at CR?” (b) “What activities did
you do at CR?” (c) “Do you have things or new ideas or other topics that need to be included
when we do this project again?” After the interview, the research assistants who did the
interviews transcribed them into Dutch verbatim. Afterwards, the Dutch version of the
interviews was translated into English, and the accuracy of the Dutch-to-English translation was confirmed.

The second set of interviews was conducted by the instructor in the programme, who acted as a research assistant and was also trained to conduct interviews. The first author was present for all the second interviews. The conversations were completed towards the end of the programme in December 2020. Since by this time some restrictions had been once again instituted by the government, the interviews took place on platforms such as Skype and Zoom, and the videos were recorded.

The questions were centred around the children’s experiences in the programme and their experiences with science at school and in other out-of-school activities. For example, some of the interview questions included: (a) “What do you think of Community Roots? Is there anything you have learned? Something you think you will remember for a long time?” (b) “Is Community Roots different from school?” (c) “Do you ever do science experiments at home? Explain what you did.” (d) “Who do you remember from the scientist who came to Community Roots?” (e) “Do you ever watch shows on TV about nature or animals?” Once the research assistant transcribed the data verbatim, the Dutch transcript was emailed to the families to verify the transcripts' accuracy. The families then confirmed or corrected the information. They also read and corrected the children’s narratives where necessary.

**Data analysis**

The interviews were recorded, transcribed, and translated into English. During the data analysis, a combination of open-coding and focused-coding strategies (Emerson et al., 2011) was based on the frameworks of Figured Worlds and Identity resources. The main researcher read through each interview to become acquainted with the content, and then questions and responses were tabulated. Afterwards, a line-by-line coding ensued for the first round of analysis. Each time the researcher copied “noticings” that stood out verbatim and made analytical memos based on questions that emerged from the data. Corbin and Strauss (2008) argue that strategies in data analysis involve raising questions and comparison of the data to develop a conceptual understanding of the data. These concepts are the attributes and dimensions that were unearthed from the data. Thus, these properties of the data unveiled patterns and contradictions across each case study and became part of the researchers’ running analytical memoing.

The second round of analysis involved the co-researchers and other critical science education researchers who are experts across the research fields of science identity, informal
science education and/or early childhood education. The second and third co-authors went through the second analysis and interpretations the primary author made separately. They then made memos in terms of their own analysis and interpretations where it was counter to the primary author. The primary author then reconciled the interpretations on her own.

The primary author also consulted with peers in the field of science education, whose expertise lay in working with early childhood and primary-aged children. The primary author presented the study to a group of research colleagues in one of their biweekly research meetings. The pseudonyms of the families were used, and all identifying information was removed except for the children’s ages and gender to maintain the anonymity of the families. The meeting served as a space to workshop ideas and discuss research-related topics, skills, and tasks to get input from the group. The primary author had been attending the research meetings of this group for more than a year when she presented the study to the group. The colleagues paired off to read through one of the children’s transcripts. In the meeting, there were about ten researchers present, and each pair had only one transcript to use. After reviewing about half of the contents of each transcript, the researchers came back together to discuss their observations.

The interpretations and patterns that emerged from the discussion during the peer checking were also documented as analytic memoing. These memos eventually became part of the data analysis (Merriam & Tisdell, 2016). These different perspectives brought in diverse interpretations and patterns and allowed the researchers to be reflective and accept responsibility to limit the influence of their biases on the analytical process (Corbin & Strauss, 2008). Once the patterns were generated, they were overlain with the theoretical and analytical frameworks to reveal how the data aligned with the constructs of Figured Worlds and Identity Resources and to answer the research questions.

**Table 5**

*Examplers from the data*

<table>
<thead>
<tr>
<th>Figured World Conceptions (Holland et al., 1998)</th>
<th>Identity Resources (Nasir and Cook, 2009)</th>
<th>Examples of patterns that emerged from the data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figured worlds are historical phenomena which develop over time, that we are drawn into and participate in. They</td>
<td>Ideational resources: Thoughts about oneself, one's relationship to and role in the practice [science] and the</td>
<td>Value of and positioning of learning in Community Roots</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mel: Well, they also have a</td>
</tr>
</tbody>
</table>
are characterised by social interactions in which we position ourselves.

Digiboard that's about the same, only they have...
Yes, it's more about the university, and at school, it's more about math and language.
Interviewer: And do you learn as much? Or do you learn less?
...
Mel: You learn a bit more at Community Roots, because that's really is about college, and you can remember that very well. (Second Interview, December 2020)

| In Figured Worlds, participants perform actions and activities. These activities are spread across a variety of diverse spheres and traditions. The objects participants use are significant in the Figured World, as these tools help them navigate these spaces. | Material resources: How one's sense of connection to the practice of science is supported by the physical setting, its organisation, and the artefacts in it. | Bridging the gap between Community Roots and the home with activities |

| Figured Worlds are socially Relational resources: These Interactions with scientist | Interviewer: And do you ever do the Roots Projects at home? Marc: I think during the previous lockdown with the skittles. We had to put the skittle on a glass of water, and then a sort of rainbow formed. (Second Interview, December 2020) | |
organised. The activities that participants perform and interactions that arise from these connections form a collective experience. Entail meaningful contact with others in surroundings that can strengthen the connections and relationships.

Interviewer: Which scientists who were at ROOTS do you remember the best?

…

Interviewer: And the astronomer, you might remember that one, too.

Marc: Oh, yes.

Celine: Because he could also play the saxophone. So, immediately there was a click.

(Second interview 2020)

Note: The information in the table shows the overlap of Figured World and Identity Resources Constructs with examples from the data.

Findings

The findings are organised by themes, with a description of the case evidence of moment-to-moment interactions across different spaces. Relational Identity resources are illustrated in the role of positive interaction with scientists, facilitators, peers, and family in shaping children’s identities. Material Identity resources include children encountering a different type of science than they are used to in school and learning about science during hands-on activities. The learning in Community Roots overlaps with home and school learning, i.e., some children shared that they learnt some topics in CR before learning them at school. They shared that the approach in CR differed from how they were taught in school, since CR was more hands-on, while at school there was more importance given to completing worksheets, etc. The Ideational Identity resources include how children showed emotional attachment to science and Community Roots – a space that engenders family science engagement. The following excerpts show how science is enacted across and within the different hybrid spaces between CR, home, and school.
Community Roots as a bridge into children’s homes

The findings that follow in this section illustrate how the programme acted as a bridge or gateway to enacting science in the home and the virtual space. There are several hybrid spaces crossed and recrossed within the interactions that follow; there are interactions between the two children doing the experiment in their respective homes; there are interactions between the facilitator and the children; and there are also interactions between the parents and the children, as they too act as facilitators assisting their children in completing the activities.

Figure 14

Zuurmeter experiment with Thom, Kenroy, Dylan

Note: This image is a snapshot of the screen as the Community Roots’ facilitators Alex and Allen were going through instructions with the boys Kenroy and Dylan, for the Zuurmeter experiment during week 14.

The activity in figure 1 is part of the do-it-yourself (DIY) experiments that they chose. The experiment is an acid base reaction done by testing household items with red cabbage juice as an indicator.

Figure 15

Testing acidity and basicity of common household products
Note: The images are showing the online lesson that occurred during week 15 of the programme when Allen, the facilitator, was working on an experiment called Zuurmeter experiment (http://smartkidslab.nl/) to test which household items are acidic or basic.

In figure 1, Allen and the boys’ parents are guiding them through the experiment as they read the instructions and gather materials to prepare for their experiments. Allen, the facilitator, asked a question, and Thom raised his finger to answer. Dylan posed a question to Allen. There is an overlap in speech and conversations as the boys interact with Allen, Allen interacts with the boys, the boys interact with their respective parents, and the boys interact with each other.

Kenroy holds up his cup with his red cabbage juice acid/base reaction. In the background, Thom’s father, Michiel, is juicing the red cabbage for the experiment. In Dylan and Kenroy’s frame, their mother Natalia is helping them to prepare their ingredients as well. Thom held up his cup of red cabbage juice acid/base reaction. He waits for his father to finish blending the juice.

From home back to Community Roots

This section highlights the fluidity of the hybrid spaces as interactions continue between home and Community Roots in another hybrid space – WhatsApp.

Figure 16
Acid-base reaction with cabbage juice

Note: The above image shows Thom standing behind his results for the Zuurmeter activity.

Thom’s father sent a WhatsApp message with figure 4 (the picture of Thom posing with his finished experiment). In this way, WhatsApp worked as another hybrid space for science enactment, as it facilitated a conversation with the purpose of investigating why the dish soap came out acidic.

**Researcher:** Michiel, thank you for your help. You can continue the experiment with Thom. Please ask him to fill in the experiment design worksheet in his notebook (if he wants to). See you next week.

**Michiel** (Thom’s father): No problem! His priorities are with the Sinterklassjournaal at the moment though. [smiley face emoji]

[Sinterklass is a legendary figure based on the patron saint of children, Saint Nicholas. The holiday is popular with children and celebrated in the Netherlands during the first week of December. The journal that Michiel referenced might have been a Thom’s homework assignment for school.]

**Researcher:** Of course. No worries.

**Michiel:** He’s already done two more though. [The] soap is turning a pretty pink with the red cabbage. [smiley face emoji]

**Researcher:** Does the soap have a citrus scent in it? It [the soap] is supposed to be basic.

**Michiel:** Yeah, that surprised me as well! It’s milk & honey scented.

**Researcher:** Interesting. [thinking face emoji].

Honey is acidic! Wow.


**Michiel:** TIL. [smiley face emoji]

That’s pretty surprising to me!

[TIL means today I learned, as in ‘TIL something interesting’.]
From these sections, it is evident that there are multiple hybrid spaces that are present and overlapping in these interactions. For example, the boys are in their respective homes gathering the supplies from the physical environment and interacting with their parents, and then they turn back to the screen to interact with Allen and each other. The home represents one of the spaces where they are interacting with the parents and working on the activity. The other space is the online space where the boys are interacting with Allen the instructor as he guides them through the activity and asks them questions. The other interaction is between the two boys themselves as they talk about what they see and experience during the science activity.

Therefore, science is being enacted in three different spaces simultaneously. Another example is that WhatsApp became another medium to continue engaging in science even after the online session ended. The WhatsApp conversation illustrates how CR offers a space to engage with science even beyond the scheduled time of the programme, and in this way the messaging platform became another hybrid space to make meaning and build everyday science knowledge. This is similar to Gutierrez and colleagues’ (1999) work where they examined language across third spaces. They also looked at the official space, official and
unofficial third spaces to incorporate the side conversations that enhance and layer meaning in the official space, where the teacher and students are asking and responding to questions. Going back to our study, this illustration gives an example of the fluidity between the hybrid spaces between Community Roots and the children’s homes.

**Across threshold from Community Roots to home family engagement**

In this illustration, the threshold children crossed is not happening during online learning, as it did in the previous examples. However, this piece of evidence offers information on how material resources cross boundaries from Community Roots into the home as children continue engaging with the activity at home with their siblings or parents.

**Mae and Loretta**

In this excerpt, Mae describes the science experiments she does at home that she learnt in Roots. She does the soap, pepper, and dish soap experiment with Minnelli (pseudonym), her little sister.

**Interviewer:** And do you do the experiments or science at home sometimes?
**Loretta:** Last week. When you got home. With that clay, and then you went to do some experiments with Minnelli [Mae’s little sister].
**Mae:** With Minelli once with that coronavirus.
**Loretta:** That's her sister, huh, that’s her little sister. She's 7 years old. Then mixed the dishwashing soap with pepper, what did you do?
**Mae:** It was the experiment where we put pepper in the water and then put our finger in and then with soap.
**Interviewer:** You wanted to show it to your sister?
**Mae:** Yeah, it seemed like something for her, too.
**Interviewer:** Did you do other experiments, or only that one?
**Loretta:** Yes, sometimes you would make something. You had a boat or something like that. Or not?

...  
**Loretta:** Mmmh, in connection with activities that she does? I don't think so. Well, every time she went to [Community Roots], she would tell her sister, and they play with the things she has learned. Yes, she did those kinds of things.

Mae plays with her sister and shows her some of the things she learns in Roots. She takes the experiments home, leaving the Community Roots space and entering her home world with these activities. Mae leaves one space as the learner and leverages the material resources to become the expert in her home world. Thus, in one figured world in the programme she is the learner, while in another figured world she pivots to the role of the expert as she ‘teaches’ her sister the science activities she learnt in Community Roots. Mae’s enactment of science as the expert helps her build a personal connection to science and supports her identity authoring.
Mel and Kelly

This excerpt reinforces the value of Community Roots, as the family enjoyed making and using the Fold-a-Scope paper microscope as a family at home. Kelly mentioned the microscopes that they had to build: the Fold-a-Scope paper microscope, an activity they started in Community Roots and finished at home. They made a video of Kelly’s hair under the microscope that was featured in the university’s science centre’s monthly newsletter.

Kelly: [Whispers]: with the microscope. Oh, no, that was me. With the microscope, we put it together there, and then we finished it together at home, and then we went to see what was underneath.
Mel: Oh yes.
Kelly: With that hair that we projected on the wall.

Interviewer: And I just heard about the microscope. You guys used that one more time at home. What did you guys put underneath it?
Mel: A hair, and a breadcrumb.
Kelly: And a leaf.
Interviewer: So you saw them up close?
Mel: Yes, one of mom's hair and one of daddy's gray hairs.
Interviewer: Okay, did it also look gray when you put it underneath?
Mel: Yes.
Kelly: It was much lighter, right?
Researcher: Oh, for that, you guys got featured in the science newsletter. That's with the microscope, right, with the hair. When you guys were looking at your hair, it was in the science newsletter.

Marc and Celine

Marc and Celine explain that they did an activity with skittles in milk. During the time the programme paused due to the Dutch government’s Covid-19 restrictions, we shared with the families activity packets and videos to keep them engaged. The primary researcher and one of the facilitators in the programme made several videos of experiments from the Science LinX “kitchen science” experiments. The booklet contained activities families could do with their children with simple materials found in the kitchen, hence the name “kitchen science”. The videos were made and shared during the summer before the programme resumed. The parents had also received a packet for Earth Day in April with a list of activities to do. Marc and Celine were the only family that had shared with us what they did. They also made a video of them doing the skittle experiment and shared it with us.

Interviewer: And do you ever do the Roots Projects at home?
Marc: I think during the previous lockdown with the skittles. We had to put the skittle on a glass of water, and then a sort of rainbow formed.

Celine: Yes, and we did some things from waste warrior or something. I don't know exactly what that's called. But then you had to eat vegetarian or that you had to buy
local vegetables. Things like that. And something with garbage, I don't remember very well. But we did those things.

**Celine:** And at home, occasionally, he finishes a project, such as the painting he finished at home, also the project with the clay.

**Marc:** Oh, yes, with the lights.

In this excerpt, we see where the programme provides Marc and Celine opportunities to engage in science experiments even outside of the structured programme hours, by way of the videos they are provided. This illustrates that Community Roots is a resource that creates a space at home for science enactment with family members.

**Crossover of all three worlds**

Here, Marc and Celine demonstrate navigating hybrid spaces created by crossing the three worlds: Community Roots, the home, and the school. In this excerpt, Celine explains how Marc shares with his father what he did in Community Roots. Here, Marc is the science expert explaining what he did and how it works to his father, based on what he learned in Community Roots.

**Celine:** The conductor. That kind of thing, he'll do it at home sometimes. He will show them to his father, and he explains it. Well, that kind of thing. Then he grabs them, and then he ties it to the micro bit or to the programmer.

**Interviewer:** Oh wow.

**Interviewer:** You take a step further. And what did you say just then? Does your father do that too? Does he know how to program?

**Marc:** He's a programmer. And sometimes he does...[?] with me.

**Interviewer:** And he teaches you things?

**Marc:** Yes.

**Interviewer:** Or do you try to do things more on your own?

**Marc:** A bit of both, because my father helps me when I program with arrows, because I have to do that with X and Y, and I find that hard. He helps me with that.

Marc and his family continued carrying out activities from Community Roots. He did the conductor lesson and then built on it to programme it with his father’s help. This highlights the value of the Community Roots space as one that affords families opportunities to continue science at home. Science continues in the home for Marc: it does not stop at Community Roots or in school, e.g., in his extracurricular class. Marc is able to tap into and maximise the resources offered by the ecological science learning model between the three worlds in which he practices science: Community Roots, home, and school.
Personal connection to science

In this section, Mae wants to be a scientist, among many professions. Though we do not know for certain if Community Roots was the catalyst for this idea, we do know that Community Roots might have encouraged and nurtured her desire to be a scientist.

**Interviewer**: Do you know what you want to be later?
**Mae**: I doubt between a lot of options.
**Loretta**: You like a lot of things.
**Mae**: I want to be a farmer, I want to be a scientist, I also want to be a teacher, and I used to want to be a doctor, but once I had a very dirty wound on my leg, and then I didn't want to, because that looked very dirty.

...  
**Interviewer**: You also said scientist, what would you like to do in science?
**Mae**: Something with nature, because I love animals and the climate very much. I also have a lot of questions about the climate.
**Interviewer**: That's good. And what do you think a scientist does?
**Mae**: Investigating a lot. That is typical science.
**Interviewer**: And if you were to tell your mother that you wanted to be a scientist, what do you think she would think?
**Mae**: I could actually ask. What would you think of it?
**Loretta**: No, but what do you think?
**Mae**: That it's typical of me.
**Loretta**: Yes, it is a bit so. You're always curious and stuff.
**Mae**: Yes, I'm super curious.

Mae describes herself as 'super curious' and prides herself on having characteristics she considers typical of a scientist. In her first interview, Mae said she wanted to be a scientist because she loves science. Here in the second interview, Mae connects her personal attribute of being curious and investigating things to being a scientist, which suggests having a deeper connection to science and increases the likelihood of her further positioning herself as a scientist. In addition, her description of herself and of what she thinks a scientist does is reinforced in the drawing she did: she sketched a woman with a magnifying wading through a swamp and looking at a bug/insect under her magnifying lens.

Among the interviewees, a recurring description of a scientist is someone who investigates things. This could be something that comes up in the meet-a-scientist sessions or what is discussed in Community Roots. Regardless of how they learnt it in the programme, it is evident that Community Roots introduces children to scientific practices.

**Mae**: Or what they looked like. I remember one of them very well, because it was last time, and she had a white jacket on, and her hair was pretty wild.

Here, Mae is describing Charlotte, a pharmacologist from the university who did a meet-the-scientist session and activity with the children that included using black pepper,
dish soap and water to demonstrate how germs spread—in light of the pandemic. Her description is typical of the mad scientist imagery. However, Charlotte is a Black woman who sported a full head of curls that day and she was wearing a white lab coat. She does not remember what Charlotte did as a pharmacologist, but she remembered the experiment with the black pepper and dish soap, her hair, and her lab coat.

**Interviewer:** Would being a scientist be something for you? What do you do that a scientist does?

**Mae:** Ask a lot of questions.

**Interviewer:** I think that is it indeed.

**Mae:** And a scientist also wants to discover everything.

**Loretta:** They also want to know everything.

Mae thinks a scientist asks a plot of questions, which ties back to being curious; and that scientists want to discover everything—although her mom (Loretta) prompted her when she said, “a scientist wants to know everything”.

**Interviewer:** Everything you see, if you don't know what it is, you want to know more about it?

**Mae:** Yes.

**Loretta:** Yes, you're gonna ask the teacher all the hard questions.

**Mae:** Back in the fifth grade my teacher was called Miss Kim and then we had a chestnut. And then I asked what was in it and then she took it all apart for me.

Mae shares a moment when the teacher reinforced what we could describe as her science identity by allowing her to open the chestnut and ‘see’ what was inside. This experience gave Mae an insight into her future self as a scientist. She takes pride in knowing that she has the characteristics of a scientist. This feeling of pride is also evident in Community Roots, and she is able to carry her identity from one figured world to another: school to Community Roots. In that lesson, Mae also recounted her experiences when going out in the woods and with a park ranger. Mae concludes that nature has to do with a bit of science too. Community Roots offered nature-based and arts-based lessons. We wonder how much of this Mae connected to her experience, as the programme incorporated all the components of what she wishes to become: a farmer and a scientist.

**Mae:** Yes, and then a boy, I don't remember his name, said ... Einstein.

**Interviewer:** Oh, yes. Remco, that was an astronomer. Were you there then, too? Do you remember anything about that?

... 

**Interviewer:** But do you remember what he did? The whole lesson?

**Mae:** He showed us a block that floats in space and it had different things in it.

Mae calls Remco, the astronomer, Einstein. This could be a transference between knowing Einstein as a scientist and seeing Remco as a scientist, which also means Mae might
not have met a scientist before Community Roots, which could extend to the value of Roots—introducing young children to science and scientists. Mae recalls the lesson with the astronomer Remco and that “block that floats in space.” This is a lesson that was done roughly two months prior. This shows learning and engagement.

Interviewer: Oh okay. Well, suppose you were allowed to work with one of them later. Would you know who you'd want to do that with?
Mae: Who do you mean?
Loretta: From the ones she just mentioned, who did you like the most?
Mae [00:28:25] Oh, the one with the planets.
Interviewer: Yes? And why him?
Mae: I'm super curious about that, too.
Loretta: Yes, she has planets everywhere and a book about planets.
Mae: Yes, I got it from Sinterklaas. And I also, can I show you that?
[Mae picks up her laptop and shows the Interviewer and Researcher her planets stickers on the wall.]

Mae liked Remco the most and remembered him because she is curious about planets. Her mom, Loretta, confirmed that Mae has planets and books about planets at home. She is interested in nature and the planets. Mae, however, did not mention what type of scientist she wants to be, so although she is not aware of the different areas of science just yet, she understands that all her activities fall under the umbrella of science.

Loretta: We downloaded something like that, didn't we? Daddy does that too, huh?
Mae: He once downloaded all the constellations. And then when you tapped on it, you knew which one it was.
Loretta: Yes, big bear and little bear.
Mae: Yes, and I also have a telescope.
Interviewer: Oh really?
Mae: Yeah, but it's a little bit broken. Luckily, I still have the lenses, they work, too.
Interviewer: So, you can just keep the lens like that and then you see it bigger?
Mae: Yes. And I got 30, 40... 40, that's the best. 30, the second-best. 20 the second worst, and 10 was the worst.

She has a telescope (not functioning at the moment). She looks at the stars with her family. Her dad downloaded the app to look at the night sky. This is evidence of family engagement with science.

Mae: Magic is also a bit of science, right?
Interviewer: Yes, I think so.
Mae: Because then I want to learn a lot of magic tricks, because I also have a magic box.

Mae mentions magic and asks if magic is science. She is into circus activities and does juggling. Here we see that a personal connection to science fosters a love of science. For Mae, most of what she remembers or likes to do has a personal connection to her life, e.g.,
the astronomy lesson resonated with her because she likes planets, and her family has a telescope, they stargaze together. This is a personal connection with science. Here we see her making sense of what science is and extending that knowledge to other facets of her life.

**Interviewer:** Mae, do you think Remco the astronomer is a scientist?
**Mae:** Yes.

**Interviewer:** And Charlotte? The one with the hair, the one with the lab coat on.
**Mae:** Yes, because she said, she also explained a lot of what a scientist does, so I guess so. And she also showed a picture of her at work with her telescope.

**Loretta:** A microscope.
**Mae:** Yes, a microscope.

When prompted, Mae mentions that Charlotte (pseudonym) is a scientist. She readily sees Remco (pseudonym) as a scientist. She mentions that Charlotte explained what a scientist does in her presentation and showed a picture with her microscope. She recognises the microscope as a tool that scientists use; therefore, Charlotte must be a scientist. Another piece of evidence that reinforces the value of Roots—introducing scientists to the children and giving them personal connections to science or strengthening the connections that they are already making at home, e.g., Mae and her family's experiences with astronomy at home.

**Marc and Celine**

In this section, Celine explains Marc’s similar interests to Remco, the astronomer, and possible connections.

**Interviewer:** Maybe then. Is there one of those scientists or one of the people we've all just mentioned that you might want to work with, for example?
**Marc:** The astronomer, but I don't remember his name.

**Interviewer:** That was Remco. And why with him?
**Marc:** Because he also plays the saxophone.

**Interviewer:** Then you can play saxophone besides work.
**Celine:** He was very excited about his story.

**Interviewer:** Maybe also because he programmed? Or because you find stars interesting?
**Celine:** Oh yes, I think he did.
**Marc:** Yes and programming. What else did he...
**Celine:** He studies the stars.
**Marc:** He does programming...and…
**Celine:** He also played with Lego, I think.
**Marc:** Oh, yes, Lego.
**Celine:** Would you like to look at the stars with him? What he's investigating. Would you like to see that, too?
**Marc:** Maybe.

Here we see another example of the value of Community Roots, as children had the opportunity to become familiar with scientists; to build a connection with scientists who they would not normally have access to. Although in the case of Celine, she shared that there are
scientists in their family. In Mae’s interview, we see that a deep connection with science is important for her to nurture her interests. For Marc, he remembers Remco and astronomy because their interests overlap, as illustrated when Marc considers his mother’s question of whether he would want to look at the stars with Remco or see what he investigates.

Crossover of learning from Community Roots to school

The following excerpts show a crossover of learning between the programme and the children’s school. A crossover means that they either learn about a topic first in Community Roots before learning about it in school; or that the topic they learnt about in school is reinforced in Community Roots.

**Loretta:** You had to build a construction with marshmallows. I think you could eat them afterwards.

**Mae:** Yes.

**Interviewer:** Do you remember what kind of construction you made then?

**Mae:** I think it’s a square construction.

**Loretta:** That had to stand firm.

**Mae:** Yeah, I also had that at school. The other day, I learned that.

**Interviewer:** Oh, did you also had to make that yourself?

**Mae:** Well, once, from newspapers.

**Interviewer:** Oh, you get that at school again.

This is another activity from the Open Day that Loretta (mom) prompted her to talk about. The marshmallow tower was a challenge at one of the tables where they had to build the tallest tower out of marshmallows and spaghetti. She then did a similar activity at school but with newspapers, and the fact that she learned this in Community Roots first also shows the value of the programme.

**Mae:** Yes, sometimes, I learn things here first than at school. About gas, the teacher was telling us about it, but I already knew that it was going to vaporise.

**Interviewer:** Oh, so, you could actually explain it?

**Mae:** Yes, actually yes.

As the kids learned some things first at Community Roots and then at school, this highlights how Community reinforced learning or introduced concepts in the school curriculum. Mae becomes the expert and is able to explain it at school because she heard about it in Community Roots.

**Interviewer:** Do you think Roots is different from school?

**Mae:** Well, yes, because at school you sometimes have to do boring work, while at [Community Roots] it's a lot more fun work. It's actually you learn a bit the same thing at both. But at [Community Roots] you do more fun experiments, and at school, you just work on your workbook. (First Interview)

This excerpt illustrates a comparison of Community Roots and school science. This
point is underscored by literature in informal science in comparison to school science: sometimes the out-of-school science experience seems more fun than the classroom experience. It could also be interpreted as fun without learning. However, this excerpt shows that Community Roots engenders a fun environment for children while they are learning about science.

**Rina, Mel, and Kelly**

In the following excerpt Rina, Mel and Kelly discuss the resources offered by Community Roots and they position Community Roots as a space of learning.

**Interviewer:** And is there anything you have learned? Something you will remember for a long time?

**Rina:** Yes, with the lamp.

**Interviewer:** So, with you with the lamp. [Here Rina might have been referring to the squishy circuits]

**Interviewer:** And with you Mel?

**Mel** [Looks at mom, and whispers]: I don't know.

**Kelly:** Should I help a little again? The other day you had a test and it was about energy and then we were able to link that back to Community Roots: Hey remember, we did that then and then. Yes, and then you understood your test even better.

**Mel:** Well, they also have a DigiBoard© that's about the same, only they have... Yes, it's more about the university, and at school, it's more about math and language.

**Interviewer:** And do you learn as much? Or do you learn less?

...**Mel:** [00:13:15] You learn a bit more at Community Roots, because that's really is about college, and you can remember that very well.

They learned about electricity in Community Roots. With this as an example, the topics they learn about in the programme form a perception that it is a place to learn about more advanced things. This is evident when Mel compared learning about science in Community Roots to learning in college.

**Time factored into the crossover of Community Roots to school**

In this illustration, we see that Marc and his mother compare the nature of science in school versus the nature of science in Community Roots. This was done by taking into account the factor of time: time is used as a meter to judge how much they have learnt in Community Roots compared to school.

**Interviewer:** And do you think ROOTS is different from school?

**Marc:** ...Yes.

**Interviewer:** Yes, what do you think is different?

**Marc:** You can do a lot more things there than at school. You don't necessarily have to do things mandatory.

**Interviewer:** Oh yes, it's without fewer commitments. And do you think you learn as
much as you do in school? Because at school you really learn a lot of course.  
**Celine:** I think at Community Roots you might learn more than at school.  
**Marc:** I don't really know. Because it is only one Saturday per week, and school is 5 days per week.  
**Celine:** Much more information in five days.  

Marc and Celine, his mom, reasoned that he might learn more in Community Roots.  
The number of days is used to measure how they learn in school. The other children, Mae, Mell, Rina, and Thom used similar reasoning in their answer.

**Crossover of school to Community Roots**

There is also a crossover of the world of school into Community Roots.

**Interviewer:** And what do you do there? What kind of things do you remember about that?  
**Marc:** We often do philosophy and have a self-development goal. Mine is usually just programming and then making things related to it.

Marc does programming in his elective class. His father is a programmer. In lesson 5, his second week, he was asked to show the class the next steps in programming the game, which offers performance science and offers an illustration of family science engagement.

**The Value of the official space**

In the excerpt below, the conversation between the interviewer and a young participant named here as Red (pseudonym) revealed that she is thinking about her future and engaging in robotics. It is evident from the excerpt that she wishes to build robots; however, her introduction to robots is via television and not in an intimate setting where she is directly involved in robotics.

**Figure 18**

*Children engaged in coding.*
Interviewer: Hey, and imagine we can continue with the project. Are there still things that you think are great fun to do?
Red: Yes.
Interviewer: Yes? Like?
Red: Make a robot or something.
Interviewer: Cool! Have you seen that somewhere?
Red: What do you mean, I don't really get it.
Interviewer: Sorry, was a bit of an unclear question from me. But how did you get that idea? Have you seen that on television?
Red: Yes, and that seems pretty cool to me, then I just have one myself.
Interviewer: Yes, I understand, I also want a robot at home. Can he clean my room nicely and stuff?
Laughter
(First interview)

Here we see Red yearns to have opportunities to experience robotics and gaming, and Community Roots offers her the resources that are not readily available to her outside of this space. This is evidence that children might want to engage in the world of robotics and gaming in the different worlds that they inhabit, be that home, school, or an out-of-school setting such as Community Roots. However, the resources and lack of accessibility limit their chances of having these experiences. Thus, Community Roots is a figured world that provides children access to these resources: children who might have limited opportunities to engage with technology in their other worlds.

Marc and Celine

In this excerpt, Marc recounts the astronomy lesson the most and recalled the fact that
there are 30 earths between the Earth and the sun.

**Interviewer:** And is there one thing you've learned that you think "I'm going to remember that forever"?

**Marc:** That there are a hundred earths between the earth and the moon, the distance.

**Interviewer:** There were 20, right?

**Marc:** Oh no, 30.

**Celine:** That is a fact that is very important to remember.

His mother, Celine, made clear that knowing the number of earths between the earth and the sun is an important fact to remember. Here we wonder why Celine thought it was so important to remember that fact. Is it because it is a scientific fact? Is it because she values science? It helps us to understand how Community Roots is seen as a figured world for knowledge consumption. Community Roots, in the official space, offers this valuable resource of knowledge-building where the children can learn scientific facts and understand scientific concepts.

**Emotional attachment in space**

The excerpts from interviews that follow illustrate evidence of the emotions that are evoked and sustained through engaging in activities that are associated with Community Roots.

**Mae**

**Mae:** Yes, and for that one, I appeared in the newspaper. With a picture and I still have it. [Mae & Loretta show the newspaper with Mae's picture on it.]

Her picture was featured in the local newspaper in an article about the event. She had the newspaper article as a memento, and she also mentioned this fact in their first interview—the interview that was done in the spring following the break in the programme. A likely explanation of why this was so memorable to her, since there was an emotional attachment, a source of pride. The ‘show and tell’ is a recurrent pattern that most of the children did. Thom, Mel and Rina did the same thing—show the thing they were talking about. It is likely that this is it a way of explaining or describing what they are talking about, e.g., Let me show you a picture. Children also brought books and their personal items to the physical space to show us, which leads to another interpretation where Community Roots engendered pride and trust.

Community Roots allowed the children to bring other parts of themselves into the space. It is illustrated by how Marc was able to give us a rendition on his saxophone when we had a lesson that was a choreographed dance and song about how earthquakes happen in the province. Marc also brought his books on earthquakes to share with us when we were
discussing the topic. Mae, who is a talented swimmer, would bring her swimming certificates to show us. These experiences could lead to the interpretation that Community Roots is a space that engenders trust and care. Furthermore, these moments also suggest that the children might have been able to bring about their whole selves to the space, and they did not need to compartmentalise their interests.

**Disrupting the images of who is a scientist**

The following excerpts illustrate how the children came to different inferences about science in relation to their interactions with the scientists and artists who visited the programme. For one, they recognised all the guests in the programme as scientists. The instructors did not make distinctions between artists and scientists and neither did the children. Everyone who spoke to them was seen as a scientist. In addition, we see the tensions in reconciling how the children perceive science to be and what science they engage in within the programme and at home.

**Interviewer:** Which scientists who were at ROOTS do you remember the best?
**Marc:** Well, the one woman from last time, anyway.
**Marc:** And another one, but she was English, so I didn't understand her, but that was also with video calling. (*Here the scientist spoke in English; it was not her nationality.*)

**Interviewer:** And do you remember what that was about?
**Marc:** How clear is the water and then an explanation.

([The scientist Marc is referring to is Charlotte. She did an activity with the Black pepper, dish soap and salt, which Mel also references in the coming section.]

**Celine:** Oh, the lady who read. You mean the one with the rainbow story?
**Marc:** That one, too. But there was also one who had a shirt with letters from a university.

Marc and Celine also recognise Wanda as a scientist. Wanda is a storyteller and author of children’s books who uses Indigenous African folktales to teach about climate change and being stewards of the earth.

**Interviewer:** And the astronomer, you might remember that one, too.
**Marc:** Oh, yes.
**Celine:** Because he could also play the saxophone. So, immediately there was a click.

...  
**Celine:** And another one, but he forgets it for a moment, the woman who was drawing the scientific drawings.
**Celine:** You found that also interesting and pretty. Also because there were some dino’s [dinosaurs]. So, I think he liked that very much and found it very interesting.
**Marc:** Oh yes, I liked that too.
Here, Celine provides that Marc remembers Remco because he also played the saxophone. Marc played the saxophone for us at Roots in the lesson with Dina, choreographing a dance and song about earthquakes. Marc remembers Lisette, an ecologist/illustrator, as a scientist.

**Mel and Karen**

In this excerpt, Mel explains how Charlotte, the pharmacologist, did an experiment with the pepper and water and dish soap, which she then did as an activity at her birthday party.

**Interviewer:** Do you ever do scientific experiments at home?
**Mel:** Yes, with my birthday I had the theme Harry Potter, which was quite a coincidence. We did an experiment, with a jug of water and pepper and with soap and you put your finger in it. We also did that one today. So, we also did it at my child-party. That was quite a coincidence.

Mel is recalling the experiment done by the scientist, which she also did at her “child-party”. This entails a juxtaposition in terms of her perception of Community Roots as college learning, and she is trying to reconcile the two. Mel’s epiphany might suggest a moment of disruption in how Mel perceives science. She mentioned before that she thinks Community Roots is like college and here, she is recollecting how the scientist did an activity that was done at a ‘child-party’. The fact that she added the word ‘child’ to differentiate the two contexts: one in which a scientist did the activity and in the second, where the same activity is performed at a party for children. It might be a key step in breaking stereotypes related to science and scientists. The first moment of disruption could be what she learnt after the lesson with Cecilia (pseudonym), a physicist: everyone can be a scientist. We could also interpret that Mel might recognise herself as a scientist, even more so when she reconciles that the experiments a scientist does in the programme are the science, she, her friends, and family do at her birthday party and at home.

**Interviewer:** Okay. And what do you want to do as a profession?
**Mel:** A Scientist.
**Interviewer:** Yes? and do you already know what you want to investigate? What do you find interesting?
**Mel:** I really like to make and examine/study them. So, if I made something, then I see if everything's still stuck on properly and if there's nothing loose. And I really like investigating things. And yes, that's just a really nice big job.

... 
**Interviewer:** And what do you think a scientist does?
**Mel:** Mostly, investigate things and see if everything is going well. And different materials and stuff and then make things with them.

Mel wants to be a scientist who makes, studies, investigates, explores, and tinkers.
These are Mel’s perceptions of scientists. These actions are similar to Mae’s personal take on seeing herself as a scientist and Red’s perception of what a scientist does. What can be interpreted from this is that the children see science as ‘doing’ and also see themselves as ‘being’ such science persons, as they use these adjectives to describe what they wish to do and how they are already engaging with science.

To summarise, we see this is a value of Community Roots as a resource: children are able to engage in scientific activities and can also envision themselves as persons who can do science. The spaces afford the children opportunities to explore and rethink their preconceived notions of what science is and who can do science. In addition, they are also forming new conceptualisations of who and what a scientist does and how they, too, can be a scientist in their imagined selves. For example, children like Mae, Marc and Red tried out their imagined selves in their prospective science careers (i.e., as a scientist who is curious, becoming a palaeontologist who goes off to far places to dig for bones to investigate and is interested in making a robot, respectively) and surmised how their personal traits fit these professions.

**Return to affordances, hybrid spaces and science identity authoring**

This study explored how a hybrid community-based STEAM-enriched programme affords children resources that they capitalise on to help them author their science identities. The research question that guided this study was what are the resources, if any, that a hybrid community-based STEAM-enriched programme offers a group of children, and, in turn, how do these support the children's authoring of their science identities? In Community Roots, we saw the cross between school boundaries and the participants' different figured worlds. The children in Community Roots leverage these affordances in their enactment of science in the hybrid spaces.

The children positioning themselves as scientists and the personal connection they have with the scientist can have lasting imprints in the way they imagine their future and potential science careers. The relational resources that the programme afforded them grounded the children’s imagining of themselves becoming scientists. The affordances, which are the resources leveraged to transform learning that was accessed in the hybrid spaces between the Figured Worlds of Community Roots, home, and school, mediated and supported these imagined identities.

The children’s personal connections to science and scientists suggest that their emotions are evoked in these experiences. Emotions and identity are intertwined, according
to Avraamidou (2019). She describes emotions as “natural”, that is, they are part of our anatomical and physiological makeup; they are “performative”, in that they are evoked in practice doing science; and they are “discursive” as they emerge through social interactions (Avraamidou, p. 331, 2019). From the perspective of this study, all three characteristics that Avraamidou (2019) outlines are present in the children’s enactment of science. According to Holland et al. (1998), identities are formed through the actions they perform in the worlds they are figured into.

Therefore, the children’s enactment of science in these hybrid spaces helps them to author their science identities and evoke emotions that further entrain them to the world of science. Avraamidou (2019) further argues that science identity is “emotional given that it involves processes of becoming which are associated with visions of self, goals, aspirations, beliefs, and enculturation in specific social, historical, and geopolitical contexts” (p. 332). Avraamidou’s (2019) argument illustrates how emotions and identity are aligned. In other words, emotions are inextricably linked to science identity authoring and, therefore, naturally emerge in the hybrid spaces where science is enacted in Community Roots, as is evidenced by the study’s data.

Family engagement in informal spaces is an opportunity as a resource that supports children’s agency in pursuit of science and, in turn, strengthens their science identity authoring, especially when it comes to parental involvement in children’s persistence in science from marginalised groups such as girls (Koch et al., 2019) and children from nondominant groups (Burke & Navas Iannini, 2021). In a quantitative study examining the relationship between childhood STEM experiences on STEM identity formation and college career pursuits, Dou et al. (2019) found that childhood experiences where children can talk with friends and family about science likely contribute to their STEM identity formation.

The findings from a case study of three African American and Latina girls who were part of an afterschool STEM club conducted by Koch et al. (2019) highlight the salient role of parental encouragement in supporting girls’ persistence in their STEM- and non-STEM-related career interests. The researchers called on informal science educators and staff to involve parents in co-designing afterschool programmes and activities. This supported girls’ STEM persistence and career trajectories by strengthening parental involvement and the ecological learning web between home, school, and afterschool activities. Community Roots answered this call and served as an example of ways to curate space for participatory methods. Safe environments encourage children and their families to do science in the physical space and at home while simultaneously learning from and with others.
In addition, the children in Community Roots leverage these affordances in their enactment of science in the hybrid spaces. The affordances in Community Roots lead to the enactment of science in the different spaces, as children shift from learners to experts and move across and within the hybrid spaces explaining the science behind the activities, which they learned in Community Roots, to their family members or peers. The shift from learner to expert is evidence of the children being figured into the world of science, a science they perceive and of which they make sense.

We turn to Holland et al. (1998) use of Bakhtin’s “space of authoring”, where the neophyte, through practised activities, positions themselves as an authority in the figured world and fashions the new identity as their own. The children in the study are undergoing a process of authoring their science identity as they develop their own “authorial stance” in “rearranging, rewording, rephrasing, and reorchestrating” their imagined selves as scientists (Holland et al., 1998, p. 183). In other words, the degree to which the children are considered proficient or novice within the figured world of science depends on how much they manipulate and manage the tools creatively: do they follow a script or improvise and is the enactment authentic?

Moreover, agency arises in these hybrid spaces of improvisation (Holland et al., 2019) as children become their imagined selves as experts in these experiences of enacting science with their siblings and families. In their science identity authoring, the agency is fostered as they gain confidence and recognise themselves as people who understand and can do science. In this light, recognition, a salient feature of science identity (Carlone & Johnson, 2007; Avraamidou, 2019), and the practice of doing science, serve as affordances in Community Roots that further mediate the children’s agency and identity development.

Though Community Roots acts as a “space of authoring” (Holland et al., 1998, p. 183) where children’s agency and identity dialectically reinforce each other as learners and experts of science (Adams & Gupta, 2015), children are not the only ones who are figured into the world of science. There is also a simultaneous shifting of novices and experts among family members who act as learners and facilitators as they engage with their children in the activities. Hence, Community Roots is an ecology of science learning that reinforces children’s future selves as scientists through their enactment of science with their families, who are recognised by and recognise their family members and peers as science persons.

In addition, Community Roots, as a STEAM-enriched programme, broadens the perspective of who a scientist is outside the institutional context. The children are given more room and openness to imagine what or who is a scientist, which is evident when they lump all
the adults who visited and taught sessions as scientists. When asked to name the scientist they remembered in their interviews, the children did not differentiate between visual and performance artists, storytellers, beekeepers, and professional scientists. The more they have been exposed to the transdisciplinary nature of science and art and how the two are mediums of improving and building upon the other—learning science through art and art through science—and not siloed disciplines, the more they (and we) challenge the conventions of who is a scientist and what is considered as science. Community Roots fosters a space for children to be more inclined and open to the different ways of knowing and being a scientist.

Implications and opportunities

In this study, we were able to follow how science was being enacted across hybrid spaces within the different Figured Worlds of Community Roots, home, and to a lesser degree, school. This chapter highlights the temporality of science and the time-space continuum. Similarly, Rahm (2012) looked at the position of girls in science and science literacy from a spatial-temporal perspective in an ethnographic study of girls’ engagement in science. The engagement was defined by girls’ participation in a newspaper activity in an afterschool programme. The notion of temporality and time required to cross different boundaries and places extend into the Figured World of virtual and material spaces.

The value of Community Roots is that it is not selective. It is open for everyone to join and is not tied to an assessment, teacher referral or any criteria other than having an interest—although having an interest implies inherent selection criteria for those who show up. Nonetheless, this is not a measure for joining the programme compared to other afterschool programmes that might have additional criteria for joining. For example, Marc and Thom are in a specialised class for advanced students where they can explore topics and activities beyond the class curriculum. Students are selected or referred based on their perceived ability. This selection criterion can limit those with a genuine interest in these programmes but do not meet the criteria.

For example, Red reported in her first interview that she had an interest in coding and loved the class where she coded a game using the Scratch platform. She even mentioned that she would like to make a robot someday, which was sparked by watching a TV programme about robots. However, the only access she had to this was by passively watching it. She had no experience doing coding at school or in an out-of-school context prior to Community Roots. This lack of access is detrimental in fostering her budding interest in robotics. Close to three decades ago, Brickhouse (1994) implored science educators to ask not what is wrong
with girls and their underrepresentation in science. Instead, we should ask what is wrong with science (Shanahan, 2009). How can girls and, thereby, women be more fully represented in the sciences?

For example, Corbett and Hill (2015) assert that inviting diverse participation in computer sciences and engineering brings innovative ideas to the fore. This argument can be extended to every other facet of science. For innovation and creativity to be a product of any initiative, equity has to be a bedrock foundation; it has to be the central focus, not an appendage or afterthought. Moreover, recognising girls as highly competent in any area of the sciences helps them to develop a strong self-image and self-confidence in their future imaginings and a sense of belonging as they envision themselves pursuing careers in these areas.

Gutiérrez and her colleagues (1999) tracked the evolution of activities and progress of children’s learning in the developmental zone of the third space in their study. Salient in their work is how the language practices helped the children make meaning of topics they discussed in the informal learning environment. The teacher’s and children’s use of their home language Spanish, as well as colloquial pairings mixed with the instructional use of Spanish and English used across the hybrid spaces supported the children’s identity. They enhanced their “learning and transformation” (p. 301). In our study, examining language and its role in identity authoring is an opportunity for us to explore.

In Community Roots, we use Dutch and English simultaneously across all the spaces as facilitators interact with families and children and vice versa. Those who were fluent in both Dutch and English, primarily the families and some of the facilitators, would switch between both languages to accommodate listeners who were dominant in either Dutch or English. Throughout the programme, we had, however, a hybrid mix of languages as non-speakers of both languages would try to communicate with each other. For example, the English-speaking facilitators, including the researcher and the children, would do a mash-up of languages as they both tried to discuss or give instructions and praises as they worked on the activities. These language practices also created a hybrid space where science, meaning making and learning were being negotiated and enacted.

The findings in the study tracked how resources were leveraged as affordances in moment-to-moment interactions, and across hybrid spaces of virtual and in-person learning environments in a community-based STEAM-enriched programme. The study design used theoretical and analytical frameworks of Figured Worlds (Holland et al., 1998) and Identity Resources (Nasir & Cooks, 2009) to highlight how children enacted science learning by
reinforcing their science identity authoring.

This study examines how students enact their multiple identities of being across different spaces. These experiences supported their future selves as science persons and underscored the importance of having spaces in informal science education for families to safely explore science. The study also highlights the degrees to which informal science education can encourage children to bring their whole selves to the space, without feeling the need to exert one aspect of themselves while silencing or limiting the other sides of their identities.
Chapter 6: Discussion and conclusion

Informal science education (ISE) researchers have long recognised the synergy that comes with an ecosystems approach to formal and informal science learning, where collaborations across different disciplines and sectors (e.g., science, technology, engineering, environmental studies, the arts and mathematics, an acronym known as STEAM) provide young learners with a wide range of 21st-century skills (OECD, 2019). These skills include applying creative and innovative solutions to issues facing their local and global communities (Monteiro, 2016), which is at the heart of the programme.

Furthermore, the authors of the PISA 2024 Strategic Vision and Direction for Science document acknowledged that “science education has the capacity to help support and equip young people with the knowledge, skills and identities (agency, attitudes, experiences, and personal and social resources, such as resilience) that will enable them, their communities and societies to tackle many challenges in the next decades.” (OECD, PISA 2024 Strategic Vision and Direction for Science, 2020, p. 2).

This thesis responded to this call. For instance, the curriculum that is the focus of this thesis is centred around becoming familiar with their local community and addressing environmental issues troubling their neighbourhood. The children are groomed to understand that their actions are part of the solution, so they develop creative ideas and skills for combatting problems in the sphere of influence. A closer look at this example includes how the children and their families created experiments and curated videos and presentations to report on the environmental and social issues plaguing their local communities. Thus, the environment this research project created at the intersection of informal and formal science education supports meaningful engagement with science and cuts across children’s life experiences.

Similarly, another salient report which has been influential in ISE and supports the purpose of this thesis is the US National Research Council’s (2009) Learning Science in Informal Environments. The authors proposed six strands, offering a guideline on how formal schools and informal science complement each other to organise and evaluate science learning. The summary of these strands includes children learning to develop critical thinking skills, engaging in scientific inquiry and practices, collaborating with their peers and experts in the field as they learn about science content, getting creative and innovative ideas, and recognising themselves as science learners, along with develop a science identity in informal science learning environments (Bell et al., 2009). These strands resonate with and align with this thesis.
Furthermore, a report by the Center for Advancement of Informal Science Education (CAISE) in the US covered thirteen interviews with expert researchers who study science identity in ISE and science communication detailing the role of identity in informal STEM learning. The interview series focused on STEM identities, interests, and engagement. The summary of the interviews broadly defines identity as an individual and social construction of one’s sense of self (Bell et al., 2019). Some researchers concurred that from a social perspective, identity is formed and negotiated through interactions.

Others conferred from a discipline perspective that STEM identity is highly contextualised. Researchers who critically examine science identity development in STEM fields also look at how individuals from nondominant groups can be marginalised, and how their identities may be constrained within STEM if they do not conform to the “traditional norms, structures, practices, and expectations in the disciplines” (Bell et al., 2018, p. 3). Though these perspectives elaborate on STEM identity, we extend these highlights to science identity, which is the focus of this thesis.

Additionally, as seen in the PISA 2024 Strategic Vision and Direction for Science previously cited, researchers have turned their attention toward an exploration of questions related to [science] identity and its salience in helping researchers to understand and to implement programmes that support children’s “agency, attitudes, experiences, and personal and social resources, such as resilience” (2020, p. 2) to sustain the interest, motivation, and engagement in science. At this turn in ISE, the thesis aims to address questions that focus on how the children participating in the project are building their skills and knowledge that, in turn, author their science identity.

This thesis is an evidence-based example of a STEAM-enriched community-based programme supporting children’s science participation and chapters four and five refer to the programme with the title “Community Roots”. Community-based informal science research is underexplored in the Netherlands, which is the context of the study. The theoretical and analytical frameworks of Figured Worlds and Identity Resources were used to analyse children’s science identity authoring.

In the coming sections, I summarise the main findings of chapters two to five, followed by the research project’s contributions, implications, limitations, and methodological reflections. A point to note here is that in the sections to follow, I use the subjective voices of ‘I’ and ‘we’ in different places in the thesis. For example, I use ‘I’ when discussing chapter three’s findings, an autoethnographic study, and issues that arise for me as the researcher. On the other hand, I use the collective ‘we’ when I refer to findings and
encounters from the collaborative efforts of co-authors and co-researchers.

**Main findings**

The foci of chapter two are grounded in the emotional state and wellness of science education teachers, specifically Black teachers in science classrooms. Throughout this chapter, I describe the emotions I experienced in my interactions with students and colleagues in our shared spaces. Emotions are a salient part of the findings in this thesis as it is illustrated, from different perspectives, how emotions impact science identity authoring. This chapter illustrates from the teacher’s perspective how her emotional state affected her classroom practice and her science teacher identity. This finding is underscored in the literature by other science education researchers such Jimenez-Liso et al. (2021) and Tobin et al. (2013).

Varying concepts of ‘space’ and resilience are also explored throughout the thesis. Instead of the physical classroom, I use the term “shared space” in chapter two. I opt to use this term when I discuss the emotion-derived experiences I have as the teacher, since they are not held in suspension in some time warp only to be encountered in the classroom's physical space. I encounter and mediate emotions related to teaching inside and outside the classroom space. I engage with a bricolage of frameworks, including hermeneutic phenomenology and event-oriented inquiry, to shed light on the varying emotions I experienced and how I strove for wellness over my teaching career. By presenting narratives of events, this chapter raises the criticality for teachers to have opportunities to learn how to engage with and ameliorate their emotions.

The chapter also offers insight into resilience being a foundation for teachers of colour and how wellness practices are a way to sustain health. Other studies (Ferguson & Martin-Dunlop, 2021; McGee, 2017; Morton & Parsons, 2018) have shown that Black women in science form groups as a way to cope with the pressures of being racialised and othered in their fields. Chapter two outlines a similar strategy: I formed affinity groups with Black women in my academic programmes. These groups provided positive emotional support and helped the group members foster coping skills such as resilience, perseverance and being successful.

The chapter adds to the existing literature on science teaching and learning, and what support teachers of colour might need to continue in science teaching. As the focus of this chapter described the sociocultural and affective domain of my science teaching identity, it also afforded me a deeper understanding when applying a similar lens to explore the science
identity authoring of the children, especially those from the Caribbean community. The experiences outlined in this chapter influenced my understanding and raised my awareness of the importance of designing an inclusive, equitable programme that supports diverse identities. Therefore, my co-researchers and I made a critically conscious decision to design a programme informed by culturally adaptive pedagogies.

In chapter three, we argued for using asset-based pedagogy, such as culturally relevant/responsive and sustaining pedagogies (CR-SP), in ISE. Creating a space for the co-construction of knowledge and offering children choices and autonomy over their learning is central to the synergy of CR-SP. Contextually and culturally, relevant pedagogies allow children to choose what they want to study and what is significant to them in their local communities. However, their choice of topics can be widespread regional or national concerns. Borrowing from Alim and Paris's (2014) argument for the case of culturally sustaining pedagogies being adopted in schools, the use of CR-SP, especially in ISE, adds to children’s (existing) body of knowledge. CR-SP does not attempt to disregard or diminish children’s ways of being but builds on their encounters and enactment of science in various contexts: with their families and friends and in their homes and communities.

Chapter three is a theoretical paper that proposes using culturally adaptive approaches such as CR-SP, especially in the Dutch context, could lead to more equitable and socially-just educational outcomes for children, particularly for Dutch Caribbean children. The question is, how do science education researchers achieve this? The chapter responds to this question by presenting the design of a community-based STEAM program framed within culturally relevant/responsive and sustainable pedagogies (CR-SP) and targeting young children with a migrant background.

The chapter further discusses children’s development of a sense of agency through immersion in a community-based programme in the Netherlands. The programme design is outlined, and there is a detailed discussion of how the tenets of CR-SP support young children. The programme's name is ROOTS: “Ik ben Science!” It is referred to as Community Roots (CR), a pseudonym, in chapters four and five, and the term will also be used in the rest of the sections of this chapter. CR is a research-based, STEAM enrichment, transdisciplinary, community-based programme that draws on science, technology, the arts, the environment, engineering, and mathematics disciplines. The programme also refers to the call for environmental sustainability beyond geographic boundaries.

Chapter four follows a critical ethnographic case study of a 12-year-old Caribbean Dutch girl. This chapter explored acts of science identity negotiation, positioning, and
authorship from different cultural and social frames. To investigate how science is enacted in a community-based science program, the study drew on the sociocultural theoretical framework of Figured Worlds (Holland et al. 1998) to study science identity coupled with Identity Resources (Nasir & Cooks, 2009) and encased in a Caribbean Diasporic narrative. The initiative was a 20-week community-based STEAM enrichment program that drew on science, technology, the arts, engineering/the environment, and mathematical disciplines. Moreover, chapter five helped to expand the boundaries of ISE to include concepts of liminality and hybridity. These concepts were taken up in the framing and analysis of this chapter allowed us to examine diasporic identities involvement in science identity authoring.

The data sources for this study came from interviews with the young girl and her aunt; video data of the lessons, research reflections and analytical memoing. Additional data that supplemented the primary data included audio data of conversations at the tables, artefacts from activities, drawings, responses in notebooks, text messages via WhatsApp, and phone conversations. The data were analysed through event-orient inquiry (Tobin, 2008) and critical narrative analysis (Souto Manning, 2014). Event-oriented inquiry guides the researcher in asking questions about what is happening and why it is happening to reveal the contradictions and patterns in the research participants’ experiences (Tobin, 2008). Critical Narrative Analysis (CNA) was used to deconstruct the participant’s actions at micro-, meso-, and macro-levels. Using CNA also supported the analysis of resilience and resistance against the metaphorical systemic or hegemonic culture of science (Souto-Manning, 2014).

The findings illustrated the ambiguities and entanglements present in the experiences of communities from the Black Diaspora—in the case of this chapter, the Caribbean Diaspora. The findings show that these experiences are perpetually suspended in these hyphenated, in-between worlds with each passing generation. The chapter illuminated the in-between-ness represented in hyphenated cultures, for example, Jamaican-hyphen-American, illustrating the complexity and contradictions within the Figured Worlds of Blackness and science.

Similarly, to chapter three, the findings in chapter four illustrate the salience of emotions and resilience in science identity authoring. The chapter’s findings show how children’s science engagement fosters positively laden emotions, such as joy and pride, which inform their science identity authoring. The findings show that informal science learning spaces support children in building up their resilience in science or their ambitions to be a science person, since the stakes are low, and support is provided in their science enactment. The chapter also highlights how the children’s agency plays a role in their science identity
authoring. In addition, Community Roots acts as a space that bridges the ecological systems of learning in formal and informal science learning. These findings are further explored and built upon in chapter five.

Chapter five presents an empirical study that explores how children author their science identities in a hybrid community-based STEAM-enriched programme. The study aimed at exploring what resources, if any, are offered in a hybrid community-based STEAM-enriched programme to a group of children. And in turn, how do these support the children's authoring of their science identities? The chapter is a collective ethnographic case study that tracks six children’s and their families' experiences as they enact science across spaces: the community-based programme, Community Roots, their home and, to a lesser extent, their school. The main data came from semi-structured interviews that were supplemented with data from video, PowerPoint presentations, drawings, and pictures that the children produced. The data were analysed through open-coding and focused-coding strategies based on the frameworks of Figured Worlds and Identity Resources.

The findings show that the children in Community Roots leverage the resources they are afforded in the hybrid spaces in their science enactment. Furthermore, the findings also highlight how children position themselves as scientists. Their emotional connection with the scientists they meet and learn more about in the programme can have lasting imprints leading to their future imaginaries of who they can be as scientists and their science careers. Moreover, the study’s findings showed that family engagement is crucial in informal spaces. The children’s families act as resources in the programme: families support their children’s agency in their pursuit of science and, in turn, strengthen their science identity authoring. Family involvement is especially salient for children from diverse populations, for example, based on their ability, gender, race, and ethnicity.

The findings of chapters four and five highlight how crucial informal science programmes are when it comes to supporting children in their local environments with community members. Thus, the importance of these community-based programmes rests in the need for children to explore their interest in science in an environment that is supportive and caring.

**Contributions**

Over 15 years ago, Osborne and Dillon (2007) opined that research in ISE is still a new field of study, in comparison to the decades-old and broader field of classroom education. This argument still holds today. ISE is a growing area of research that provides
insights into science learning and teaching.

The first part of this thesis deals focused on the role of emotions and resilience in science identity authoring. Chapter two is an autobiographical position paper on how I, as an AfroCaribbean science teacher, mitigated my emotions in a predominantly white profession. The narratives look at how science teachers of colour constantly negotiate emotions in the classroom and schools where they work. The narratives also raised the issue of resilience as a foundation in their science identity authoring.

The US context, where this chapter is set, provides a platform for critical conservations around how science teachers of colour are racialised and how that could potentially impact their decisions to stay in the classroom or leave the teaching profession. These conversations are crucial to stemming the attrition of science teachers of colour. In addition to having these critical conversations around representation of diverse groups in the formal science classroom arena, highlighting that representation matters in ISE is equally crucial. Although this chapter focused on my journey in the science, it also provides evidence of the emotional labour that ISE educators of colour might likely encounter in informal education setting. ISE has been spaces that offer supportive environments for children of colour to learn STEM disciplines (Joseph et al., 2017) and part of that supportive environment also includes the diversity in the educators that are engaging children. To this end, the chapter also informed the decision to include more diversity and inclusion of topics and also invite a diverse group of volunteers and scientists to facilitate lessons and offer workshops. Furthermore, having a diverse instructional staff and volunteers is taking steps towards multicultural practices, which are a crucial aspect of a CR-SP-designed curriculum.

Chapter three deals with the need for culturally adaptive pedagogies to undergird the curriculum in ISE. The PhD project, Roots: Ik ben Science! served as an exemplar of an out-school programme designed using a synergy of culturally responsive/relevant and sustaining pedagogies (CR-SP). This was outlined in chapter three, which gave an overview of the units of topics, how they were executed, and how they reflected the different tenets of CR-SP. The curricular design and programme offer a concrete example for other educators working with primary-aged children in ISE. In particular, this programme, in particular, brings a unique perspective on encompassing CR-SP-designed curricular when working with children in the Netherlands. Though there are still challenges when designing a curriculum using CR-SP (Smith et al., 2022), this study serves as a starting point for the added benefits of creating an inclusive and socially-just informal science programme.

In addition to the curriculum design, the research project was a STEAM-enriched
programme. Having a STEAM-enriched programme illustrated the transdisciplinary focus of the research project where it integrated the arts and nature with the science topics in the lessons. Transdisciplinary unifies different branches of knowledge. It is not a singular discipline but rather what exists across, within, and beyond disciplines (Basarab Nicolescu, 2005). During the programme, a transdisciplinary approach helped us convey to the children and their families the complexity of our world while also recognising and understanding science in our everyday actions.

Chapter four looked at diasporic identity and science identity authoring based on the case study of a Caribbean Dutch girl. Chapter four also examined the role of emotions and resilience on science identity authoring. The chapter illustrates how children experience positively-valenced emotions in enacting science in an informal science setting. It also raises the need to examine the interplay between resilience and science identity among children in the context of ISE.

Furthermore, the thesis takes up the concept of hybridity from two different perspectives: the study discussed hybridity in terms of culture and then examined it from spatial and temporal boundaries. First, let us look at the cultural aspect of hybridity examined in chapter four. In looking at cultural identity, we examined the position of the Caribbean diaspora in science identity work by looking at the case of Red, a young Caribbean Dutch girl in the programme. Stuart Hall’s writings on the Caribbean diaspora serve as the architectural grounding for conceptualising Caribbean Diasporic Identity in chapter four. Hall (1999/2019) writes that the concept of “diaspora” is one of great familiarity among Caribbean people. As Hall writes (1999/2019), to Caribbean people, diaspora is a “collective sense of self…” that is “…deeply written…” (p. 208) in our history: in the metropolises of the colonial imperial lands, we emigrated to, and in the history of the islands that became our homelands, from where we came.

This chapter contributes to science education literature and, more particularly, carries out research on the Black diaspora and science identity (Ferguson & Martin-Dunlop, 2021; McGee & Bentley, 2017; Morton &Nkrumah, 2021), particularly the Caribbean Diasporic Identity (Adams, 2022; Miller, 2017). Furthermore, another contribution is that this thesis presents the narrative from a child’s perspective in a colonial imperial context. In this chapter, the Caribbean Diasporic Identity came to stand in for Blackness in Europe as the context of Caribbean-ness is explored, specifically the Caribbean Dutch identity in the Netherlands.

Another concept introduced in chapter four of this thesis is that of liminality. In
examining hybridity through a cultural lens, liminality was also explored. Liminal spaces were rich zones of production. Rahm (2008) studied hybridised identities of Quebec youths and their positioning in science. In her paper, she argued the importance of understanding hybridised identities further in order to understand their participation or lack thereof in science.

The study was conducted nearly 15 years ago, but it still holds today, especially when considering diversity and inclusion in ISE. Rahm (2008) illustrated the value of examining the tensions and conflict that result from hybridity. In these liminal spaces, youth make meaning of their positioning in science and how they can imagine themselves navigating the world of science in the future. This thesis also examines the tension of cultural hybridity and liminality in juxtaposition to the positioning and identity in science through the case of Red. The study adds to the literature on how these spaces of hybridity provide a deeper understanding of multiculturalism in science education and ISE, in particular.

The findings also showed that the enactment of science in the home, the programme and the school created a hybrid space that provided the affordances that children access and navigate in the various spaces. Moreover, children exercised their agency as they shifted from learners to experts across hybrid spaces. The literature supports this finding on the interplay between agency and science identity development (Adams, 2015). The children’s increased agency also strengthens their science identity authoring. This research study provides empirical evidence on how children navigate and participate in the world of science in out-of-school contexts. That is, how they view, talk about and engage with science. This evidence also includes how their participation supports their science identity authoring and encourages future imaginings and possibilities in their pursuit of science fields.

A more practical contribution of this thesis is the inclusion of families in the programme — the community-based approach of the programme allowed for more family engagement. In addition, we saw increased family involvement in the lessons as we adapted to the COVID-19 pandemic and shifted to online learning. In chapters four and five, we see where family engagement in informal spaces provides an opportunity and a resource to further support children’s agency in pursuit of science is and strengthen their science identity authoring.

To conclude, the findings of this thesis contribute to the knowledge base and growing field of science identity research in ISE.
Implications for theory

This thesis focuses on exploring and theorising about space in the physical and metaphorical sense. Therefore, ‘space’ is examined from different angles. One of these is dedicated to liminal spaces, the in-between, hybrid spaces of culture and the physical hybrid spaces of virtual and in-person science learning. In the thesis, the programme acts as a place where children author their science identities; that is, through this “space of authoring” (Holland et al., 1998, p.183), children are figured into the world of science. They are in the process of developing their science identities.

Hybridity is also a concept taken up in this thesis from multiple perspectives. On the one hand, chapter four uses the notion of hybridity in terms of culture. This hybrid space is described as a liminal space, an ‘in-between’ space where the Caribbean Diaspora takes up residence in foreign lands. On the other hand, chapter five discusses the hybrid zone as spatial and temporal boundaries. The concept of hybridity in a cultural sense as well as a time-space orientation and its impact on children’s science identity are not new to ISE research. For example, Jrène Rahm (2008) examined how youths from different cultural and immigrant backgrounds navigated the world of science in a school-based afterschool programme in Québec. Likewise, science education researchers such as Calabrese Barton, Tan, and colleagues (2013) also examined the hybrid learning spaces that African American girls occupy in an after-school programme, their homes and school.

Comparatively, the theoretical and analytical construct used in chapters four and five combines Holland et al.'s (1998) Figured Worlds and Nasir and Cooks' (2009) Identity Resources. Layering these constructs afforded a further examination of the resources the children explored and enacted in these spaces, as well as of how these enactments influenced their science identity authoring. Additionally, the findings in this thesis emphasise the resources that are available to children and their families in informal science environments outside the traditional formal schooling contexts. These out-of-school contexts are instrumental in supporting children’s understanding of and strengthening their motivation and interest in science in their everyday lives (Tal & Dierking, 2014).

In exploring the Caribbean Diaspora in chapters three and four, we also explore blackness in two different contexts: the United States and the Netherlands. In the US context, talking about blackness is more explicit and in open discourse when juxtaposed with whiteness. However, in the Netherlands, there is more of a colourblind approach to conversations centred around blackness. Renowned legal scholar, Kimberlé Crenshaw
(2019), in giving a keynote address\textsuperscript{1}, called out the failure of colourblind frameworks in education. She pointed out that they perpetuate colonial ideology because they do not explicitly address and dismantle the structural hierarchy and oppression embedded in the foundation of education.

Similarly, colonial hegemony and ideology continue to surface within formal and informal science environments because the roots of systemic oppression have not been destroyed. This thesis raises questions about what it means to be Black in Europe and what it means to be white. How does this viewpoint play out for the Black Diaspora, and more specifically, the Caribbean Diaspora, to be in a colonial imperial society? And how do all these raised issues affect the positioning of children within the diaspora in the world of science?

\textbf{Implications for methodology and research}

The implications discussed in this section focus on methodology and research. In the methodology section, I discuss the implications of using multiple methods of inquiry in the analysis of the data. Then, in the research implications, I go on to highlight the importance of further studies that align with this thesis's focus, which is children’s science identity authoring in informal science environments.

\textbf{Methodological implications}

Obstacles and contradictions are integral components of research (Malyukova, 2021), especially qualitative research. The employed research process can be described as one that is emergent and contingent. Specifically, employing bricolage opened the door to using auto-ethnography and ethnography methodologies in the thesis — in order to highlight and make sense of the contradictions raised in the study. It allowed for the analysis to rely on multiple perspectives, while also drawing on different interpretations of the data.

A qualitative researcher is a bricoleur weaving together different “tools, methods and techniques” to represent, analyse and interpret the data (Denzin & Lincoln, 2011, p. 4). A "bricolage is …multiple methods of inquiry [and] diverse theoretical and philosophical” approaches and perspectives (Kincheloe, 2011, p. 180). As already mentioned, this thesis is emergent and contingent: we allowed the data to guide our theoretical framing and analysis. Using bricolage opened up the data analysis for deeper understanding and richer interpretation.

In employing an autoethnographic methodology in chapter two, as the
autoethnographer I became the bricoleur. Ellis and colleagues (2011) write that autoethnography acknowledges and accommodates subjectivity, emotionality, and the researcher’s influence on research, rather than hiding from these matters or assuming that they do not exist (p. 274). In this way, autoethnography allowed me, the researcher, to examine my emotions and their role in teacher science identity.

In addition, using event-oriented inquiry in chapter four was another tool of bricolage. Event-oriented inquiry allowed us to ask questions about what is happening, why it is happening, and what else is there (Tobin, 2008). For research, ethnographers seek to uncover and illuminate unfamiliar processes. Digging deeper and searching wider with the help of these inquiry questions encourage ethnographers to uncover the lived experiences of individuals. For instance, the findings provided insights into emotions and resilience, along with their impact on science identity authoring in a community-based STEAM-enriched programme.

**Research implications**

The research implications of this thesis offer opportunities for longitudinal research and research in partnership with schools to see the effect of ISE on children’s science participation, engagement, motivation, and interest. This thesis serves as a basis for a longitudinal study where researchers can track children’s science pathways and trajectories when they participate in informal science environments. Longitudinal studies will afford ISE researchers the opportunity to understand what kind of support children and families are seeking, as well as what will help the children develop a robust science identity. This knowledge will allow ISE researchers to design and implement programmes with the goal of supporting children and families, especially within groups that are usually underrepresented in informal science spaces and science participation (e.g., girls, ethnically and racially diverse populations). Moreover, it would be especially useful to see the impact of adopting curricular that are designed using culturally adaptive pedagogies.

Similarly, classroom partnerships with community-based ISE might lend themselves to an ecosystem-based approach with more involvement from families and family stakeholders. According to prominent informal science educators Falk and Dierking (2018), an ecosystem-based approach supports a “…total community-wide set of educational offerings…” that are “…able to support science learning year after year despite ever-changing economic, social and political conditions” (p. 13).

Such an approach provides children and families with a network of material and
social resources across formal and informal science education landscapes that they can connect with, and thereby encourages and sustains their motivation and interests in science. Therefore, further research into school partnerships with community-based ISE in the Netherlands may provide more evidence and insight into the effect of these approaches on children’s engagement with science, and whether they pursue science as a field of study in higher grades.

As mentioned in the prior section on theoretical implications, the findings in this thesis underscore the value of ISE, as it offers resources that support children’s science identity authoring. Therefore, a larger sample size would offer more diverse perspectives and include a broader representation of the impact of ISE on children and families in the Netherlands. Besides a larger participant pool might highlight more resources that children may have (or may not have) access to in informal science environments.

This argument is a salient point for further research on what programmes can offer children and families to increase and sustain their interests and participation in science. In line with the focus of this thesis, research with larger numbers of participants in the Netherlands may also provide a broader view and deeper understanding of how these resources (which were accessed in informal environments outside of the formal school setting) are impacting children’s science identity development.

**Implications for practice and policy**

This section highlights the implications of this thesis regarding practice and policy. In the section on practice, I highlight the general impact of using culturally adaptive pedagogies and having a transdisciplinary approach in the curricular design of the programme. Next, I outline the implications for policy by showcasing how this thesis supports already existing policies that increase the public’s access to science and raise the standing of science in the Netherlands.

**Practical implications**

A practical implication of this thesis is using culturally adaptive pedagogies, such as culturally responsive/relevant and sustaining pedagogies, as well as the transdisciplinary approach of using STEAM in designing the after-school programme.

A curriculum designed using culturally adaptive pedagogies incorporates the family’s and community’s ideas, experiences, and ways of being. In her pioneering book on culturally relevant pedagogy, *The Dreamkeepers*, Gloria Ladson-Billings (1995) argues that including these culturally adaptive pedagogies in curricular design and teaching incites a love of
oneself, family, and community; encourages children to challenge ideologies that dismiss or diminish the value of their culture, family, community, and ways of being and empowers children to strive for excellence in every facet of their lives. Ladson-Billings also extends these arguments to children’s families. In addition, she argues that using culturally relevant pedagogies, which we hereby insert as culturally adaptive pedagogies, empowers families to demand the best for their children from all levels of the educational state, i.e., from the local and community level to the education department at the state and national government. We had, therefore, incorporated such approaches in the curricular design and instruction of the programme.

Consequently, the curriculum introduces the potential to have an integrated curricular design where art supports science, and science facilitates art. A child, for example, does not need to separate their love for science and the performance or visual arts but can embrace both interests and, subsequently, both parts of their identity, to make the two complement each other. The research project of this thesis offers a transdisciplinary focus in which there is no separation of disciplines, but integration instead. It was also evident in the findings that children understand science through the arts and see their future selves integrating both arenas of study.

In addition, the programme is an example of how science education researchers can strengthen the informal-formal ecological learning spaces. The community-based model allows creative ideas to flow between the institution and community members — this is especially true for family involvement. In addition, when children are persistent in science, especially those from nondominant groups in community-based settings, they can shift from novices to experts as they act as learners and facilitators engaging in the activities. Hence, the project ‘Roots: Ik ben Science!’ is an ecology of science learning that reinforces children’s future selves as scientists through their enactment of science with their families. In addition, these children are able to be recognised by (and also recognise) their family members and peers as science people. These community-based programmes are safe environments that encourage children and their families to do science while learning from and with others.

**Policy implications**

This thesis provides evidence of the benefit of fully integrated ISE into formal education and, thereby, the Dutch national education curriculum. For one, this implication supports the Ministry of Education, Culture and Science’s National Science Agenda. The
ministry aims to have a Dutch society that is fully scientifically literate where there is full integration, cross-pollination and “... ‘co-creation’…” of ideas between “...researchers, scientists, the private sector, civil society, the government and other stakeholders” (Ministry of Education, Culture and Science, 2025 Vision for Science, 2020, p. 24).

In addition, the 2025 Vision for Science document identifies that ISE is essential in connecting and making science super-visible to the Dutch public: i.e., “the media, social media, television programmes, science museums, public debates, exhibitions, e-learning (e.g., the ‘massive online open courses, or MOOCs) and the ‘science shops’” (p. 46). It also identified events such as the Weekend of Science, where the public can access different science activities in cities across the Netherlands. These science weekends are collaborations across universities, ISE institutions, and public and private sectors. Similarly, the research project, ‘Roots: Ik ben Science!’, which is the focus of this thesis, is a collaboration of various stakeholders that includes researchers from the university, the university science centre, scientists, and students from the alpha and beta sciences (health, psychology, astronomy, physics and science education and communication), visual and performance artists and families.

Moreover, the ministry committed to having science and technology as part of the education curriculum supported by the “... ‘Dutch Technology Pact 2020’...” (Ministry of Education, Culture and Science, 2025 Vision for Science, 2020, p. 46). Here we advocate for government policy to go a step further and propose that the ISE be fully integrated and required in the school curriculum instead of on the periphery, supporting education as an adjacent. The findings in this thesis illustrate the advantages of an ecosystem of resources obtained through a community-led ISE model that integrates cultural centres and the arts to enhance the creativity and innovation of the sciences. This model thereby supports the 2025 Vision for Science in the efforts to involve all stakeholders to raise the standards of science in the Netherlands. As much as museums, science centres, and other ISE institutions are great resources to engage the public in science, community-based informal science spaces bring science to the people in their neighbourhoods.

Thus, the findings in this thesis posit community-based ISE as a great resource to foster interest and increase participation in science. Additionally, it offers a foundation for ISE to become adopted wholly into the school curriculum through more formalised school partnerships with informal science institutions and community-based informal science spaces.
Limitations and methodological reflections

Regardless of the theoretical and empirical contributions, there are some limitations to the design and execution of this research project. First, let us reflect on the curricular design of the programme. The curriculum is framed using culturally adaptive pedagogies such as culturally relevant/responsive and sustaining pedagogies. Though this curricular design responds to a more inclusive and diverse approach to informal science engagement, it still presents some challenges. For example, in hybridised or diasporic communities, such as the focus group in chapter three, there is an assumption that occurs on the researcher's part that is imposed on the children. The authors did note that they were mindful of the risk of overreaching and imposing what they think it means to be the Dutch Caribbean. However, even though the first and third authors are from Caribbean backgrounds, there has to be a constant reflection on the researchers’ and/or curriculum designers' part so as not to impose what they think is relevant to the children in the program.

Another limitation in the project’s research design is the examination of language, or, rather, the lack thereof, and its role in the children’s science identity. Dutch and English were simultaneously used in the programme, with everyone interacting. This means facilitators who are native English speakers interact with families and children who are native Dutch speakers using a hybrid Dutch-English mixture. Some facilitators and families are fluent in both languages and serve as translators for language learners of the respective language.

However, it must be noted that language is a marker of identity (Bergman et al., 2008). Its use in everyday conversations to convey and interpret, along with its use in the more formal documentation of power cements its role as a key player in constructing social and cultural identity. At the same time, as mentioned in several places in this thesis, science identity is a cultural and social construction. Science education researcher Felicia Mensah Moore (2007) argued that science has its own discourse and, therefore, borrowing from Paul Gee’s theory on Discourse, it produces a culture of power within science. Moore (2007) further posits that “…understanding the language, rules and discourses of science content…” grants one access to the upper rungs of the cultural hierarchy built into classroom science. “Scientific discourse is manifested through language” (Mensah Moore, 2007, p. 321).

In applying Mensah Moore’s (2007) argument that science is a language of cultural power within the classroom to the informal science learning context, we can examine how communicating science discourse in one language over the other can, albeit unintentionally, create a hierarchy. Switching between English and Dutch might create a certain level of
hybridity in communication. However, if left unexamined, one language may be deemed ‘preferable’ in scientific discourse—and therefore, the ones who can speak and understand this ‘preferred’ language with ease are deemed more capable of navigating the scientific arena. In other words, one can be deemed more or less suitable for the world of science depending on the language one speaks.

In addition, the lack of examination of the role of language and its hybridity in science meaning-making and learning (which could have been added to the knowledge base on the role of language in ISE) is a missed opportunity in this PhD project. Siry and colleagues (2012) assert that children in multilingual classrooms enact science through discourse-in-interaction. That is, the culture of and learning science are achieved through interactions. Therefore, according to Siry et al. (2012), children’s understanding of science and the construction of knowledge is achieved in this collaborative interactional discourse. The context of the researcher’s study is the science classroom. Thus, this study missed the chance to explore the effect of language on children’s enactment of science in an informal science learning setting.

In following up on the idea of co-construction of knowledge, another approach that could encourage more collaborative efforts between the researchers, families, and children is to employ participatory action research (PAR) to better match the community-based approaches used in this study. The assumption that the participants hold the local knowledge and expertise based on their everyday practices and experiences is the guiding principle that underpins this methodological approach (Rodríguez & Brown, 2009). PAR is an action-oriented approach where participants work toward an outcome—an action—while simultaneously undergoing research. That means the research and action are carried out concurrently (Rudman, 2018).

According to Rudman and colleagues (2018), PAR “is practice-led, rather than practice-based, and contrasts with traditional scientific research where participants are objects of the study” (p. 570). Though we attempted to use photovoice, a form of action research used in community and educational settings (Bellino, 2015), as a data source in the project, it was used only as a secondary source of data.

However, a more targeted approach to PAR would yield better results as participants are seen as stakeholders (Rudman et al., 2018). There were no selection criteria, and the children and families who participated in the study were interested in science. Therefore, they might have valued being co-producers and co-designers—fully integrated with the curricular and research design. Even though there is no perfect methodology when it comes to research,
as there will always be constraints and limitations in the research design, using PAR in the research design would help engender agency among participants: they would collaborate with the researchers to take part in the decision-making and direction-shaping of the project.

In addition to finding a methodology well-suited for the design of the project, another crucial element to consider when doing qualitative research is reflexivity. Self-reflexivity is especially important when doing critical ethnographic research (Sullivan, 1996). These considerations are also related to what is ethical to minimise the participants' discomfort in the research. Reflexivity is an analysis of one’s assumptions, biases, theoretical and methodological positioning, and relationship as an observer-participant in the research (Merriam & Tisdell, 2016). Thus, it is crucial to engage in reflexivity as part of qualitative research.

One such consideration is related to the methods of data collection and analysis. Using multimodal methods to analyse the data is to consider the trial and error of video recording and analysis beforehand. For example, the physical positioning of the camera when recording up close to capture facial expressions: although it may seem insignificant, as the researcher, I had reservations about being too close to the camera. I felt that I was invading the participant’s personal space. Therefore, I would orient the camera at a certain distance from the participant during sessions.

However, once we began reviewing video data and needed closer encounters to do a microanalysis of emotions, the realisation dawned that the shots were too far away. Only the more experienced researcher's camera shots closer to the participant captured facial expressions that could be used for such microanalysis. As much as it was a matter of ethical consideration, as the PhD researcher, my discomfort could have been rectified by having a conversation with the participant.

Another matter of ethical importance in qualitative research in informal science settings is the preparation one undertakes in entering and exiting the programme. Though this research project is different to those in which ethnographers go to different contexts to study cultures foreign to their own, taking time to appropriately enter and exit the programme is a matter of building care and trust among your participants and disrupting the extractive nature of ethnographic research. We had an open day to commence the programme and ended with a celebration with all the children that completed it.

However, it would have been better to give children and their families ample time to adjust to the programme ending after a certain period. Although it was on the flyer when families were being recruited (with the pause in between the project also being mentioned),
some families did not remember that the programme was going to end. They needed more time to prepare for the fact that the relationships they had built up over time with the facilitators and other participants would end. The researcher has tried to keep in touch with families, but this is not enough when ending a programme with a community-based focus.

Another point of reflection in this research project is my positioning in the research and as the researcher throughout the study. Being an AfroCaribbean woman is a salient part of my identity, influencing how I would describe the Dutch Caribbean community. For example, the early days of the research project used the description of AfroCaribbean Dutch, which is evident in the theoretical paper in chapter two. In chapter two, the use of the term ‘AfroCaribbean’ appeared frequently. This identifier evolved and the prefix ‘afro’ was dropped because it is not a true reflection of the mixture of races and ethnic groups among Caribbean descendants.

Then there was the choice of using Caribbean Dutch or Dutch Caribbean. The nuance between the two terminologies is that one denotes an immigrant status, while the other one indicates having been born Dutch. The term Caribbean Dutch felt more comfortable for me since hyphenated identifiers are used in the US context: for example, one can identify as Jamaican-American or Caribbean-American. However, ‘Caribbean Dutch’ was not a terminology popular within the context. Though I use ‘Dutch Caribbean’ when referring to the collective experiences or community as a whole, I eventually settled on using the identifier Caribbean or being of Dutch Caribbean descent when speaking about individual identity. In the end, I found that the shift in terminology reflected my growth as a critical researcher and my heightened awareness of the context and cultural nuances of the study. Moreover, using these identifiers highlighted the hybridised identity of the Dutch Caribbean diaspora living in the Netherlands.

**Final note**

On a balmy Monday morning in July, battling the high heat and humidity, I stood outside the old Erasmus High School building with my students in Brooklyn, New York. We were all enraptured by Shanna Sabio’s storytelling, the co-founder and co-director of GROWHouse, NYC, a Black-led design and development collective. Shanna led us on a morning walking tour of the Flatbush African Burial Ground. As I stood there, listening to Shanna bring history alive for my students and me, I could not help but reflect on Katherine McKittrick’s (2013) work as she writes about Black geographies and bodies: more so, the impossibility of delinking Blackness from the space in which we stood.
Blackness is ingrained in the city's material, physical, chemical, and biological makeup (McKittrick, 2013). As Shanna pointed out, the original Erasmus school house — now a heritage site — built by the early Dutch settlers was similar to the street names that served as evidence of the slaveholding and land-owning families of that time. I thought of how our Black bodies bore witness to the time-space continuum that McKittrick (2013) speaks of, where they “trace the past to the present and the present to the past through geography” (p. 7). I connect this to the fact that the Black Diaspora lives a hybrid experience which is permanently tethered to the past as we navigate the present in which we are grounded whilst mapping out a life for the future.

As Rinaldo Walcott (2021) entreats scholars to carry out research in Black Diaspora studies, while also underscoring the work of fellow Caribbean Thinker, a daughter of the Diaspora, Sylvia Wynter, one has to examine the far-reach of brutality colonialism left in the wake of European expansion on Black bodies. Walcott (2021) strongly implores that Black Diaspora studies cannot separate themselves from Indigenous studies. Scholars also have to seriously consider the near genocide of and continuous violence against Indigenous populations in the discourse of coloniality and its role in Black life. This assertion is present in the narrative of the Caribbean Diaspora: we are a mixture of cultures and ethnicities and must also consider Native studies in our pursuit of Caribbean scholarship.

In looking beyond the scope of this thesis, how do we, as science educators, begin to unravel these historical, socio- and geo-spatial entanglements to understand and address the position of the Black Diaspora within science education? The findings of chapters two, three and four of the thesis are an attempt to answer this question, though the answers are still in a stage of infancy. Chapter five supports existing research evidence pointing to the value of socio-and geospatial interactions in science with the families that participated in the project and negotiating the space-time continuum in science — which is geographically situated rather than linear.
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Appendices

Appendix A

Table A1

*Methods of data collection: Active family participation*

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<tr>
<th>Tool</th>
<th>When</th>
<th>Question it addresses</th>
<th>Notes</th>
<th>Example</th>
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<tbody>
<tr>
<td>Photovoice</td>
<td>Weekly</td>
<td>How are children’s science identities shaped through their engagement in a CRP-informed, community-based, STEAM program?</td>
<td>Students will be assigned to send in photos every week. See the progression of how they relate to science. Collected weekly; however, a minimum of five photos spread over time will tell a story. Children can take pictures on their parents’ phones and send them via WhatsApp with a voice or typed message saying what it means to them or how science is represented in the photo. Take one or more photos…</td>
<td>Subero et al., 2017 (autobiographic linked to funds of identity)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How are Dutch-Caribbean students positioned within the culture of science?</td>
<td></td>
<td>Bellino &amp; Adams, 2017 (Critical socio-environmental issues &amp; PAR method)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How do they position themselves in science? How do they come to form disrupting science identities?</td>
<td></td>
<td>Strong et al. (2016) (YPAR or PAR)</td>
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<td>Daniel &amp; Logie (2016)</td>
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<td>Wang &amp; Burris (1997)</td>
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<td>Catalani &amp; Minkler (2010)</td>
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environmental pedagogy to re-imagine environmental education for youth agency and participation. Using photovoice will elicit how the children’s views science and what it means to them from their point of reference. It will give us insight into the child’s positioning in the figured world of science, a world they ascribe meaning to. Moreover, it will illustrate their science identity formation over the course of the project. This one? What does this mean?

Children discuss/reflect on 1. Give a title to the picture 2. how do they see science represented in the photograph? Meaning what was conveyed in the image. 3. What does it mean to them? or why? 4. What it means to them

Children can send a WhatsApp audio recording of their responses in their preferred language. Or they can type it and text or email it to me. They can also write it down on paper and give it to me the following week.

They will post on the Roots website gallery.

Tips for getting them to send in their photos:

<table>
<thead>
<tr>
<th>Science Box for identity mapping</th>
<th>Once</th>
<th>How are Dutch-Caribbean students positioned within the culture of science?</th>
<th>This is a great storytelling tool for young children instead of drawing and writing an identity map.</th>
<th>Subero et al., 2017 (shoeboxes, ‘All About Me Box’)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>How do the different types of identity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview</td>
<td>Twic...</td>
<td>How are Dutch-Caribbean students positioned within the culture of science? How do they position themselves in science? How do they form, negotiate, and author their science identities? How do the different types of identity resources support student development?</td>
<td>~30-60 minutes semi-structured interviews with targeted Children and parents. Already completed the first round.</td>
<td>Avraamidou, 2019; King &amp; Pringle, 2019; Kozoll &amp; Osbourne, 2004; Wieselmann et al., 2020</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>of disrupting science identities?</td>
<td>the Buurt or wherever they want.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Try out questions with kids.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ask questions that the parents and children can answer together: e.g., What did you learn about science? What has your child taught you or brought home? Keep in the framework in identity parents’ perceptions. Emphasis on recognition. What changes have you noticed with the kids? (This could be coupled with photovoice and track changes over time.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B

### Table B1

*Methods of data collection: Passive family participation*

<table>
<thead>
<tr>
<th>Tool</th>
<th>When</th>
<th>Questions Addressed</th>
<th>Notes</th>
<th>Example Literature (a previous empirical study that used the data collection tool)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical memoing</td>
<td>Collected Weekly</td>
<td>All four questions</td>
<td>Memoing will be both a data collection tool and a preliminary analytical tool. The video, audio and reflections will be the source of data for the analytical memo.</td>
<td>Martin, S. (2020 ESERA VDN Summer school)</td>
</tr>
<tr>
<td>Activity artefacts</td>
<td>Collected Weekly</td>
<td>How are children's science identities shaped through their engagement in a CRP-informed, community-based, STEAM program?</td>
<td>Activity artefacts can be used for priming during the interview as well. Assign someone to take pictures before they leave pictures and write the name of students for each picture</td>
<td>Kim (2018)</td>
</tr>
<tr>
<td>Video/audio</td>
<td>Collected Weekly</td>
<td>How are Dutch-Caribbean students positioned within the culture of science? How do they position themselves in science?</td>
<td>How do the different types of identity resources support student development of disrupting science identities?</td>
<td>This will capture the children’s engagement and be used as an observation tool.</td>
</tr>
<tr>
<td>-------------</td>
<td>------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Reflection/Observation notes</td>
<td>Collected Weekly</td>
<td>How are Dutch-Caribbean students positioned within the culture of science?</td>
<td>This will be my weekly reflections of what happened, questions raised, etc.</td>
<td>Lopez Lopez, L. L. &amp; Nikey (2020)</td>
</tr>
<tr>
<td>Volunteers/instructors</td>
<td>*For volunteers, only brief feedback after the lesson</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Appendix C**

**Table C1**

*Methods of data collections: peripheral data*

<table>
<thead>
<tr>
<th>Tool</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text messages</td>
<td>Text messages from parents communicate with me.</td>
</tr>
<tr>
<td>Pictures</td>
<td>Pictures of children’s work. They tend to take home what they have made. So, a photograph is important to capture the final product.</td>
</tr>
<tr>
<td>Reflection - Volunteers/instructors</td>
<td>Volunteers can share their reflections on the activity via a voice message or email.</td>
</tr>
</tbody>
</table>
Appendix D

Sample of possible interview questions discussed prior to commencement of second phase study.

What do you think about when you do science at home and in Community Roots?

1. Tell me about times when you feel like a science at school?
2. Tell me about times when you feel like a science person at home?
3. Tell me about times when you feel like a science person in Community Roots?
4. Do you feel that you are good at science or like you can do science well? What makes you feel that way?
5. Do you feel like you can perform science tasks and use science skills? For example, can you use the scientific inquiry process, can you measure different variables, like the pH of water? What makes you feel that way?
6. Do you feel like your peers, teachers or family recognize you as a science person? Do they see you as someone that can do science well or is good at science? What makes you feel that way?
7. What do you think of when I say “scientist” versus “science person”?
8. Tell me about ‘X’ picture. Why do you think this represents science?


Example of the mid-way check in with some of the children

Questions for Red
What do you think about Roots?
What do you think about science? Would you want to become a scientist? What do you think you would need to do to become a scientist? You said science is too hard?

Questions for Marc
Your mom tells me you want to become a scientist. What does a scientist do? Why do you want to become a scientist?

Questions for Mae
What do you think about Roots?
Do you want to become a scientist? What do you think a scientist does?
## Appendix E

### Table E1

*Example of the check-ins and framework to guide the research: targeted data collection over the remainder of the 8 weeks*

<table>
<thead>
<tr>
<th>Date (#)</th>
<th>Lesson Topic</th>
<th>Task</th>
<th>Identity resources</th>
<th>Data collection that would lead to an evaluation of identity (development)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31/10/20 (Week 8)</td>
<td>Astronomy</td>
<td></td>
<td>-Tasks that target the development of all or one identity component (which one &amp; how)</td>
<td></td>
</tr>
<tr>
<td>7/11/20 (Week 9)</td>
<td>Draw yourself as a scientist? Robotics</td>
<td>Targets recognition of how they see themselves as scientists and how they view science. Emphasise on a context versus how they look.</td>
<td>More explorative of their recognition of themselves as scientists and how they view science</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td>Description</td>
<td>Performance of</td>
<td>Notes</td>
</tr>
<tr>
<td>------------</td>
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<td>------------------------------------------------------------------------------</td>
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<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14/11/20</td>
<td>Meet-a-Scientist</td>
<td>Assign making videos. Myself as a scientist: My science journey and also share about themselves.</td>
<td>Performance of <em>other</em> scientists.</td>
<td>Would need to ask questions of how they see Caroline as a scientist may be in comparison to the astronomer and the artist.</td>
</tr>
<tr>
<td></td>
<td>Caroline Plant as Medicine</td>
<td>Videos give a sense of historicity/triangulation.</td>
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<tr>
<td></td>
<td></td>
<td>Ask Red- what else would you like to do if she doesn't want to do the videos?</td>
<td></td>
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<tr>
<td>21/11/20</td>
<td>Improv or Robotics</td>
<td>Show how they have engaged with science out-of-school, with family, by themselves.</td>
<td>All three components: recognition, competence, and performance.</td>
<td>Targets recognition of families.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>28/11/20</td>
<td>Art with Nola Meet-a-Scientist</td>
<td>Draw yourself or someone else doing scientist?</td>
<td>Diversity of science careers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make a comic book of scientists doing science.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collage of what science means to them. Make vision boards/Pinterest of science.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/12/20</td>
<td>Science Experiments</td>
<td>Conducting <em>their own</em> experiments.</td>
<td>Performance and competence</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>12/12/20</td>
<td>Science Experiments</td>
<td>Conducting <em>their own</em> experiments.</td>
<td>Performance and competence</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Description</td>
<td></td>
<td></td>
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<tr>
<td>------------</td>
<td>-------------</td>
<td>------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>19/12/20</td>
<td>Science Fair</td>
<td>Present science experiments. Show their competence and performance as a scientist.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix F

Needs assessment

Qualitative interview with families: A needs assessment to determine if the community is open for an after-school programme

Parents

1. Do you involve your child(ren) in science?
2. What are your aspirations for your child(ren)?
3. Do you want them to pursue a career in science?
4. How do you help your child(ren) to achieve this goal?
5. What do you think an afterschool science programme is?
6. How would such a programme help your child(ren) to achieve their plan in science?

Children

1. Do you like science?
2. What do you do after school?
3. What do you think about joining an after-school programme to do science?
### Appendix G

#### Table G1

*Example of unit of lesson topics in the second phase of project (September to December 2020)*

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Lesson topic</th>
<th>Notes</th>
<th>Volunteers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>September 12</td>
<td>Circuit Breaker Lesson</td>
<td>In Singapore, they use the term “circuit breaker” instead of lockdown b/c of its negative connotation. This lesson, although not a central point, will address the COVID-19 virus and implications (age-appropriate) through a lesson on building a circuit.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="https://www.makerspaces.com/squishy-circuits/?fbclid=IwAR2gZ5IU">https://www.makerspaces.com/squishy-circuits/?fbclid=IwAR2gZ5IU</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>September 19</td>
<td>Bee Lesson with parent instructor</td>
<td>Molly is a beekeeper and also does lessons on beekeeping. She did a lesson with the Bestuur (Nature scouts) that went well. She will repeat that lesson with Roots. NB: It’s the end of the season but kids might be able to see honeybees but not bumblebees.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>September 26</td>
<td>Do a gallery walk with the photographs the children took. Scout**- Seavenging for edible plants in the woods; observing plants with foldscopes; press plants for a keepsake; making a salad with plants</td>
<td>Chatting with physicist* Will skip this part. Kids can come back with follow up questions for physicist. **The scouts begin at 11 am and ends at 1 pm</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>October 3</td>
<td>Earthquake (intro to earthquakes and seismic activity) Lesson: <a href="https://www.teachengineering.org/lessons/view/cub_seismicw_lesson01">https://www.teachengineering.org/lessons/view/cub_seismicw_lesson01</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Lesson topic</td>
<td>Notes</td>
<td></td>
<td></td>
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<tr>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 October 10</td>
<td>Dance: Earthquake themed to illustrate S-waves and P-waves in an earthquake</td>
<td>Aletta Jacobs Installation (COVID-19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 October 17</td>
<td>Earthquake w/ documentarian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 October 24</td>
<td>Earthquake w/ documentarian</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 October 31</td>
<td>Observatory, Leiden University Astronomy Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 November 7</td>
<td>Improv theatre, Energy bus/ Science *</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 November 14</td>
<td>Plants as Medicine, Meet a Scientist 2 (pharmacologist)</td>
<td></td>
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</tr>
<tr>
<td>1 November 21</td>
<td>Robotics cont’d</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 November 28</td>
<td>Art with visual artist, Meet a Scientist* 3 (artists and art psychologist)</td>
<td>The smart labs are the meet-o-theek lessons. The ‘meet a scientist’ segment is a 15-minute or less introduction to a scientist and what they do. The children will be able to ask questions afterwards or send their questions later.</td>
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</tr>
<tr>
<td>1 December 3</td>
<td>D.I.Y. personal experiments with smartlabs.nl experiment, Meet with scientist 5 (?)</td>
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</tr>
<tr>
<td>1 December 4</td>
<td>Finalise D.I.Y. experiment, Meet a Scientist 6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1 December 5</td>
<td>Final celebration, Project displays, Planetarium*</td>
<td>Waiting to hear back if the planetarium can be used and if there is a discount for RUG staff to reserve it. Everyone’s invited!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Alternative To In-Person Meetings (in case of lockdown) (October - December)**

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Lesson topic</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>October 31</td>
<td>Leiden University Astronomy Group</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>November 7</td>
<td>D.I.Y. personal experiments with smart labs, Meet-o-Theek</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>November 14</td>
<td>Draw yourself as a scientist. Meet-a-Scientist: Pharmacist</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>November 21</td>
<td>D.I.Y. personal experiments with smartlabs.nl</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>November 28</td>
<td>Present Experiments</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Date</td>
<td>Lesson Topic</td>
<td>Notes</td>
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<tr>
<td>-----</td>
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<td>---------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>13</td>
<td>December 5</td>
<td>Video Myself as Scientist: My Science Journey</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>December 12</td>
<td>Art w/ visual artist</td>
<td>Will need to get supplies to families</td>
</tr>
<tr>
<td>15</td>
<td>December 19</td>
<td>Celebration The children show their own videos.</td>
<td>Deliver Award certificate of participation to families with goodie bags</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show video of time in Roots</td>
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</tbody>
</table>

**If we come back in-person in December**

<table>
<thead>
<tr>
<th>#</th>
<th>Date</th>
<th>Lesson Topic</th>
<th>Notes</th>
<th>Alternative lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>December 5</td>
<td>Art w/ visual artist</td>
<td></td>
<td>Robotics</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>December 12</td>
<td>Plant as Medicine</td>
<td></td>
<td>Robotics</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>December 19</td>
<td>Celebration and presentations, Award certificate of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>participation, buttons</td>
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</tbody>
</table>
Appendix H

Example of lesson plan

**Topic:** Buzzing Bees: Everything about Bees  
Saturday, September 19, 2020  
**Time:** 10:30-12 noon  
**Location:**

Lesson: Explore, observe bees, and identify the differences between honeybees, bumblebees, and flying insects, for example, a bee has four wings, and a fly only has two.

<table>
<thead>
<tr>
<th>Time</th>
<th>Lesson outline</th>
<th>Notes</th>
<th>Co-facilitators</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 - 10:40</td>
<td>Welcome + Ice breaker</td>
<td>Location on the ball court</td>
<td>Researcher Jane (lead)</td>
</tr>
<tr>
<td></td>
<td>Ice breaker game: Zip (move to the right), Zap (move to the left) and Zoop (across from you)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check-in: What did we do in Roots last week?</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>How was your weekend and what do have planned for the upcoming week?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:40 - 11:50</td>
<td>Activity Overview (15 minutes)</td>
<td>May will close with questions from the children and families. Volunteers too!</td>
<td>Researcher Parent facilitator (lead)</td>
</tr>
<tr>
<td></td>
<td>Animals are very good finding their way different than humans do, e.g., bees see ultraviolet. What we see is not how the animals observe. Watch things closely and explore and find out how it works.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Scavenger hunt (15 minutes)</td>
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</tr>
<tr>
<td></td>
<td>Children will have scavenger to find different bees and insects. The children will get a copy of a dichotomous key.</td>
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</tr>
<tr>
<td></td>
<td>2. Mimicry (15 minutes)</td>
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<tr>
<td></td>
<td>Why is mimicry important? Wasp and flies that mimic bees. Why do they do it?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The bees can see ultraviolet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shares examples of mimicry.</td>
<td></td>
<td>Researcher (Lead) Jane</td>
</tr>
</tbody>
</table>
3. **Architecture (15 minutes)**
   Children will investigate how different shapes work with fitting the honeycomb. Children a paper they will have to (circle, square and hexagon).

Close (10 minutes)

Marjolein will close with questions from the children and families. Volunteers too!

**Actionable outcome:**
1. Children will count bees in April in the *Nederland Zoemt Bijentelling*, a national bee counting citizen project. Get the contact information for Marjolein.

**Materials**
1. Laminated bee and insect guides
2. Different shaped stamps: circle, square and hexagon
3. Picture of another mimicry in nature of plants and flowers and spot the mimics.
4. A picture of a flower, the way we see it and what the bees see it.

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Facilitator</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:50 - 12:00</td>
<td>Administrative stuff</td>
<td>Researcher (lead)</td>
</tr>
<tr>
<td></td>
<td>Snacks, clean up.</td>
<td></td>
</tr>
<tr>
<td>Reflection</td>
<td>What went well?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What needs to be improved?</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I

Earth Day, 22 april

Wat doe je voor Earth Day?
Dit jaar markeert de 50e verjaardag van Earth Day. Turning Green Classrooms (www.turninggreenclassroom.org) biedt activiteiten die je helpen bij te dragen aan een duurzame omgeving. Dit is een belangrijk onderdeel van Roots: "Ik ben Science!"

Laten we beginnen! 😊

1. Bereken je ecologische voetafdruk met deze rekenaar van het Global Footprint Network. Dit is in meerdere talen verkrijgbaar. Het wordt echter niet in het Nederlands aangeboden. (Het wordt gesponsord door een Nederlands bedrijf!).


Earth Day, 22 April

What are you doing for Earth Day?
This year marks the 50th anniversary of Earth Day. Turning Green Classrooms (www.turninggreenclassroom.org) offers activities that help you contribute to a sustainable environment. This is an important part of Roots: “Ik ben Science!”

Let’s begin! 😊

1. Calculate your carbon footprint using this calculator from the Global Footprint Network. This is in multiple languages. However, it is not offered in Dutch. (It’s sponsored by a Dutch company!).

2. Challenge yourself and complete one of the five activities. They range from easy to super challenges. Of course, you can complete more than one of the activities.

Bereken uw ecologische voetafdruk


2. Deel je actie met vrienden en familie. Moedig hen aan hetzelfde te doen.

3. Stuur je resultaten naar t.s.smith@rug.nl of WhatsApp +31 6 381 427 57.

Optioneel. Tag je resultaten op sociale media @TurningGreenOrg en voeg #TGClassroom toe.
Vind meer informatie op https://www.turninggreenclassroom.org/activities/day-2-footprint/.

Calculate your carbon footprint

1. Calculate your carbon footprint using this calculator from the Global Footprint Network. This is the website: https://www.footprintcalculator.org/.

2. Share your action with friends and family. Encourage them to do the same.

3. Send your results to t.s.smith@rug.nl of WhatsApp +31 6 381 427 57.

Optional. Tag your results on social media @TurningGreenOrg and include #TGClassroom.

Find more information at https://www.turninggreenclassroom.org/activities/day-2-footprint/

Ben je klaar voor een uitdaging?
Are you up for a challenge?

Daag jezelf uit en voltooi een van de vijf activiteiten.
Challenge yourself and complete one of the five activities.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Level of Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meatless Monday (of elke dag die je kiest)</td>
<td>Laag</td>
</tr>
<tr>
<td>Ga een dag vleesvrij.</td>
<td></td>
</tr>
<tr>
<td><em>Meatless Monday (or any day you choose)</em></td>
<td></td>
</tr>
<tr>
<td>Go meat-free for a day.</td>
<td></td>
</tr>
<tr>
<td>Eten Prep</td>
<td>Medium</td>
</tr>
<tr>
<td>Bereid met jouw ezin een maaltijd met locale, verse, seizoensgebonden en voedzame ingrediënten.</td>
<td></td>
</tr>
<tr>
<td>Food Prep</td>
<td>Prepare a meal with your family with locally-produced, fresh, seasonal and nutritious ingredients.</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mode dag</td>
<td>Gebruik oude kleding om modieuze creaties te maken.</td>
</tr>
<tr>
<td>Fashion Day</td>
<td>Repurpose old clothes to make fashionable creations.</td>
</tr>
<tr>
<td>DIY-dag</td>
<td>Maak je eigen doe-het-zelf-recept met ingrediënten die thuis verkrijgbaar zijn.</td>
</tr>
<tr>
<td>DIY Day</td>
<td>Make your own DIY recipe from ingredients available at home.</td>
</tr>
<tr>
<td>Food Waste</td>
<td>Feed the animals in the park with your food scraps (fruits, vegetables, greens, stale bread, etc.).</td>
</tr>
<tr>
<td>Food Waste</td>
<td>Build a backyard compost or prepare a compost pail.</td>
</tr>
<tr>
<td>Voedsel verspilling</td>
<td>Voor de dieren in het park met voedselresten (fruit, groenten, groenten, oud brood, enz.).</td>
</tr>
<tr>
<td>Food Waste</td>
<td>Feed the animals in the park with your food scraps (fruits, vegetables, greens, stale bread, etc.).</td>
</tr>
<tr>
<td>Voedsel verspilling</td>
<td>Bouw een compostbak in de achtertuin of bereid een compostemmer voor.</td>
</tr>
</tbody>
</table>

Vind meer informatie op [www.turninggreenclassroom.org](http://www.turninggreenclassroom.org).

**Meatless Mondays (of elke dag die je kiest)**

Zelfs een dag minder vlees eten heeft een positieve impact op uw gezondheid en het milieu.

1. Vervang dierlijke producten met fruit, groenten, noten, zaden, peulvruchten en planten voor ontbijt, lunch, dinner en snack tijd.
2. Nodig je familie en vrienden uit om met je mee te doen aan de uitdaging.
4. Stuur je foto's naar [t.s.smith@rug.nl](mailto:t.s.smith@rug.nl) of WhatsApp +31 6 381 427 57.

*Optioneel.* Tag jouw resultaten op sociale media @TurningGreenOrg en voeg #TGClassroom toe.

Vind meer informatie op [https://www.turninggreenclassroom.org/activities/day-13-meatless-monday/](https://www.turninggreenclassroom.org/activities/day-13-meatless-monday/)
Meatless Mondays (or whenever you choose)

Consuming less meat for even one day will have a positive impact on your health and the environment.

1. Replace animal products with fruits, vegetables, nuts, seeds, legumes and plants for breakfast, lunch, dinner, and snack time.

2. Invite your family and friends to join you in the challenge.

3. Take photos and add captions to record what you, family and friends eat.

4. Send your photos to t.s.smith@rug.nl or WhatsApp +31 6 381 427 57.

Optional. Tag your results on social media @TurningGreenOrg and include #TGClassroom.

See more at https://www.turninggreenclassroom.org/activities/day-13-meatless-monday/.

Source: http://blog.farmfreshtoyou.com/2019/04/meatless-monday.html

Eten Prep
Bereid een maaltijd voor met uw gezin.

1. Zoek naar zoveel verse, lokale, seizoensgebonden voedzame ingrediënten die je thuis kunt vinden.

2. Brainstorm met je gezin om manieren te bedenken om een eenvoudig gerecht te bereiden met de ingrediënten die u bij de hand heeft.

3. Maak foto's met onderschriften of maak een video (ongeveer 60 seconden lang) om het proces voor recept- en maaltijdbereiding te laten zien.

4. Stuur je foto's naar t.s.smith@rug.nl of WhatsApp +31 6 381 427 57.

Optional. Tag uw resultaten op sociale media @TurningGreenOrg en voeg #TGClassroom toe.

Vind meer informatie op https://www.turninggreenclassroom.org/activities/day-8-food/.

Food Prep
Prepare a meal with your family.

1. Look for as many fresh, local, seasonal nutritious ingredients you can find at home.
2. Brainstorm with your family to think of ways to prepare a simple dish with the ingredients you have on hand.

3. Take photos with captions or create a video (about 60 seconds long) to show the process for recipe and meal preparation.

4. Send your photos to t.s.smith@rug.nl or WhatsApp +31 6 381 427 57.

Optional. Tag your results on social media @TurningGreenOrg and include #TGClassroom. See more at https://www.turninggreenclassroom.org/activities/day-8-food/.

Source: https://groenegroninger.blogspot.com/search/label/Zelf%20groen%20doen

DIY Produkt
Wat we op ons lichaam doen, kan schadelijker zijn dan we denken.

1. Probeer een doe-het-zelfrecept met ingrediënten die je thuis hebt. Zie een aparte lijst bijgevoegd met aanbevolen recepten.


4. Stuur je foto's of video naar t.s.smith@rug.nl of WhatsApp +31 6 381 427 57.

Optional. Tag je resultaten op sociale media @TurningGreenOrg en voeg #TGClassroom toe.

Vind meer informatie op https://www.turninggreenclassroom.org/activities/day-17body/.

DIY Product
What we put on our bodies may be more harmful than we think.

1. Try a DIY recipe with ingredients you have at home. See a separate list bookmarked with recommended recipes.

2. Invite your family to make the DIY product together with you.

3. Take photos and add captions or create a short video to document the process.
4. Send your photos or video to t.s.smith@rug.nl or WhatsApp +31 6 381 427 57.

Optional. Tag your results on social media @TurningGreenOrg and include #TGClassroom. See more at https://www.turninggreenclassroom.org/activities/day-17body/.

Thandeka’s Body Butter: “I just used what I have at home: Shea butter, coconut oil, vitamin E oil and a touch of maizena.”

Voedselverspilling: voedselverspilling?

Voedselverspilling betekent dat alle middelen die nodig zijn om het voedsel te maken, verloren zijn gegaan. Het verminderen van voedselverspilling heeft een grote impact op het verminderen van de CO2-uitstoot.


2. Bewaar jouw etensresten en voer de dieren de volgende keer dat je met jouw gezin op bezoek komt in het park.

3. Als je in de buurt van een boerderij bent, kun je ook de boerderijdieren voeren.

4. Maak foto's en voeg onderschriften toe om het voederen van dieren te documenteren.

5. Stuur je foto's naar t.s.smith@rug.nl of WhatsApp +31 6 381 427 57.

Food Waste: Got Food Scrap?

Food waste means that all the resources that went into making the food went to waste. Reducing food waste will have a high impact on reducing carbon emissions.

1. Feed the animals in the park with your food scraps. If you are allowed to feed, the deers and goats in the park, for example.

2. Save your food scrap and feed the animals in the park the next time you visit with your family.

3. If you are nearby a farm, you can feed the farm animals.

4. Take photos and add captions to document the animal feeding.

5. Send your photos to t.s.smith@rug.nl or WhatsApp +31 6 381 427 57.
Voedselverspilling: composteren

Composteren is een geweldige goedkope manier om voedselverspilling tegen te gaan. Het biedt rijke voedingsstoffen die een gezonde bodem ondersteunen om planten te helpen groeien en bloeien.

1. **Bouw een compostbak. Zie hoe Peppa Pig het doet!**

2. **Klik hier ook om te zien hoe u een plastic fles kunt hergebruiken om een mini-compostbak te maken.**


4. Stuur je video en foto naar **t.s.smith@rug.nl** of **WhatsApp +31 6 381 427 57**.

Optioneel. Deel de foto met een onderschrift over het positieve verschil dat het maakt bij het aanpakken van de voedselverspillingcrisis op Instagram, Facebook of Twitter. Tag uw resultaten op sociale media @TurningGreenOrg en voeg #TGClassroom toe.


Food Waste: Composting

Composting is a great low-cost way of reducing food waste. It provides rich nutrients that support healthy soil to help plants grow and flourish.

1. **Build a compost bin or prepare a compost pail**. See how Peppa Pig does it!

2. Also, click **here** to see how to repurpose a plastic bottle to make a mini-compost bin.

3. Create a video of the task and take a picture of the final product. Add a caption to the photo.

4. Send your video and photo to **t.s.smith@rug.nl** or **WhatsApp +31 6 381 427 57**.

Optional. Share the photo with a caption about the positive difference it makes in addressing the food waste crisis on Instagram, Facebook, or Twitter. Tag your results on social media
Het waterbad voorbereiden
Preparing the water bath
1. Vul een pot halverwege met water.
   Fill a pot halfway with water.

2. Plaats vervolgens een glazen of aluminium bakje met water in de pot.
   Then place a glass or aluminium container in the pot with water.

3. Plaats de pot met het bakje op de kookplaat / kachel.
   Place the pot with the container on the hotplate/stove.

4. Laat het water aan de kook komen voordat je de boter of was in de binnenbak doet.
   Let the water come to a boil before adding the butter or wax to the inside container.

Shea Butter Deodorant
Shea Butter Deodorant Instructions
1. Smelt sheaboter en kokosolie in een waterbad tot ze nauwelijks zijn gesmolten.
   Melt shea butter and coconut oil in a water bath until barely melted.

2. Verwijder van het vuur en voeg zuiveringszout en arrowroot toe.
   Remove from heat and add baking soda and arrowroot.


   Add essential oils and pour into a glass container. Leave to cool without the lid.

5. Schroef het deksel op de glazen container voor opslag.
   Screw the lid on the glass container for storage.

6. Het hoeft niet in de koelkast te worden bewaard, hoewel het in deze zomerse hitte kan smelten!
It does not need to be stored in the fridge, though it may melt in this summer heat!

✯ Coconut Oil Deodorant ✯

- 6 eetlepels Kokosolie (lichtjes gesmolten).
  6 tbsp Coconut oil (slightly melted)
- ¼ kopje (4 eetlepels) Zuiveringszout.
  ¼ cup (4 tbsp) Baking soda
- ¼ kopje Arrowroot (maizena kan ook worden gebruikt).
  ¼ cup Arrowroot (cornstarch can be used as well)
- 20 drops of essential oil (essential oils like grapefruit or tea tree have antibacterial properties)
  20 drops of essential oil (essential oils like grapefruit or tea tree oil have antibacterial properties)
- Kleine container

Coconut Oil Deodorant Instructions
1. Meng zuiveringszout en pijlwortel in een middelgrote kom.
  Mix baking soda and arrowroot together in a medium sized bowl.
2. Pureer in lichtjes gesmolten kokosolie met een vork tot alles goed gemengd is.
  Mash in slightly melted coconut oil with a fork until well mixed.
  Add oils, if desired. Store in a small glass jar or old deodorant container for easy use.

✯ Lip Balm ✯

- ½ kopje (8 eetlepels) Bijenwas (geraspt en gesmolten)
  ½ cup (8 tbsp) Beeswax (grated and melted)
- 2 eetlepels kokos olie
  2 tbsp Coconut oil
- 1 theelepel amandelextract of essentiële olie van amandel (andere etherische oliën kunnen worden gebruikt)
  1 tsp Almond extract or almond essential oil (other essential oils can be used)
- Kleine container

Lip Balm Instructions
1. Smelt geraspte bijenwas (of gebruik pellets) en kokosolie in een waterbad.
  Melt grated beeswax (or use pellets) and coconut oil in a water bath.
2. Voeg etherische oliën toe en meng goed. Add essential oils and mix well.
  Pour mixture into a glass container. Leave to cool without the lid.
Sachet Bags

Sachets zijn zakjes gevuld met kruiden en geurende olie. Kalmerende en herstellende sachets kunnen ook als afweermiddel worden gebruikt.

Sachets are bags filled with herbs and scented oil. Soothing and re-energizing sachets can be used as repellents as well.

Hier enkele ideeën voor uw persoonlijke zakjes:

- **Russische wijze**: Geassocieerd met vrouwen. Zou angst, slapeloosheid helpen
  
  Associated with women. Supposed to help anxiety, insomnia
  
  - Lemon balm: Kalmerend, bevordert de slaap.
    
    Calming, promotes sleep
  
  - Pineapple mint: stimulerend, bevordert de alertheid
    
    Stimulating, promotes alertness
  
  - Peppermint: verfrissend, stemmend.
    
    Refreshing, mood-elevating
  
  - Spearmint: Zachtter dan pepermunt, verfrissend
    
    Gentler than peppermint, refreshing
  
  - Lavender: bevordert kalmte, slaap, verlicht hoofdpijn; ook stimulerend
    
    Promotes calm, sleep, relieves headache; also stimulating

Goed Gevolg

👍 🙌
Summary

This PhD research project is an evidence-based example of a STEAM-enriched community-based programme that aims to support children’s participation in science. Additionally, the thesis is an example of the benefits of adopting a culturally adaptive curriculum in informal science education (ISE).

Community-based informal science research is underexplored in the Netherlands, which is the context of the study. The theoretical and analytical frameworks of Figured Worlds and Identity Resources were used to analyse children’s science identity authoring.

The findings of the study shine a light on the relationship between community-based science learning and children’s engagement with and participation in science. More specifically, we see how families’ science engagement informs science instruction and supports children’s science identities.

Chapter two entitled “Culturally relevant/responsive and sustainable pedagogies in science education: theoretical perspectives and curriculum implications” is a critical review of the condition of informal science education in the Netherlands, with a primary focus on the Dutch Caribbean community, which has received little research attention in educational research.

The theoretical chapter puts forward an argument for the inclusion of more culturally-based pedagogies in informal science education using the programme Roots: Ik ben Science as a concrete example. The chapter gives an overview of the relevant asset-based pedagogies, such as culturally relevant/responsive and sustaining pedagogies, and how it is used in the community-based S.T.E.A.M.-enriched programme for young children and their parents in the Netherlands.

Where does it hurt?

In my inner soul, my inner being like...
What does it feel like?
It feels like a fractioning of who I am: a loss of my self-confidence and self-worth and like feeling less than.
Right.
That’s what feeling less than brings about: pain.
Because you are experiencing this pain that you’re going through, this, like onslaught of not being enough in the space you are.
The pain of never being enough, right?
Never being enough in the space and always trying to prove otherwise. 
[You feel as if you are an interloper] working hard to prove that you belong. 
In this space. 
In the place. 
In this space not only a teacher, but as a science teacher. 
Always proving that you are, proving that I am capable of doing it. 
I am doing it. 
And, also, trying to prove that I should be accepted. 
Right. 
So always like this. So that’s what I wanted to convey, that this: trying to prove your worth all the time. 
So, I belong here, so I need to prove to you that I belong here, and I need other students to know that they need to prove to the world that they too belong there. (Smith, 2022, p. 138)

Chapter three, “A wellness project: An AfroCaribbean science teacher’s quest for healing”, follows an auto-ethnographic study of my experiences as an AfroCaribbean public school science teacher in New York City. Using hermeneutic phenomenology as the theoretical framing, I explored the different emotions I experienced as a racialised "Other" in a majority-white school and society. Through the lens of event-oriented and narrative inquiry, I tracked my emotions, which is a central theme in my story. The chapter offers insight into the life of a science teacher from the Caribbean diaspora and introduces Caribbean Diasporic Identity and Science Identity Authoring from the perspective of a teacher from the AngloCaribbean living in the United States. It also informed the research project's design and served as an extended positionality statement that speaks to my insider/outsider status as a researcher in the study.

The Diaspora
Scattered...
...Fragmented
Coalescing in the
In between spaces

We, women of the Caribbean diaspora, write ourselves into intellectual existence
As we move from frame to frame, that is country to country, homeland to foreign land and to once-was-my-parent’s land.
Finally, to settle in the in-between.
We interpret, analyse and theorise the stock we done come from.
From that place in-between, we look inwards, backwards, and forwards to interpret, analyse, and theorise as we...
Identify as...
Are positioned as...

To Become as... (2021 Annual NARST Conference, 8 April 2021)

Chapter four which is entitled “Occupying spaces of liminality and Hybridity: Exploring a Caribbean Dutch Girl’s Positioning and Identity in a Community-based Science Programme” foregrounds the experiences of a young girl from a Dutch Caribbean background living in the Netherlands. In this chapter, we follow a young girl’s story named Red through an ethnographic single case study to provide the backdrop to further theorise about Caribbean Diasporic Identities and the connection to Science Identity authoring. The link that bridges these two chapters is the nuanced experiences of the Caribbean Diaspora. The implications of this chapter, with video analysis, further provide evidence of the role of emotions and resilience in science identity authoring and family engagement in informal science education research.

Who are you?
Who am I?
I am...

Hybridised, never one or the other
Occupying spaces in-between
Learning in dis place, the in-between place
I am...

The single parts that make up my whole
I am a bricolage of identities

Lastly, chapter five, “Exploring hybrid spaces: children’s identity authoring in a community-based STEAM-enriched programme” is an ethnographic collective case study that presents how resources are leveraged in the interactions across hybrid virtual and in-person learning spaces in the community-based STEAM-enriched programme. Holland et al.’s (1998) Figured World and Nasir & Cooks’ (2009) Identity Resources were used as the analytical frameworks to analyse the interviews and video data sources with…[participants]. Moreover, the study showed the importance of having informal science environments for families to safely explore science and help them support their children’s science identity authoring. The study’s implications include how children’s experiences in informal science
support their views of their future selves as science persons.

The thesis provides new theoretical insights on how children might author science identities when offered opportunities to engage in personally relevant and meaningful ways with science. Second, it provides evidence of the critical role of families in nurturing such engagement. Third, it showcases how out-of-school settings can be curated to afford opportunities for envisioning possible futures. Finally, it offers a concrete example of how informal science education is a rich context to foster children’s science identity, authoring and supporting science engagement from diverse backgrounds and contexts.
Samenvatting in het Nederlands

Dit PhD-onderzoeksproject is een evidence-based voorbeeld van een STEAM-gerelateerd gemeenschap gebaseerd programma dat als doel heeft de betrokkenheid van kinderen in wetenschap te ondersteunen. Ook is dit proefschrift een voorbeeld van de voordelen van het toepassen van een cultureel adaptief curriculum in informeel wetenschapsonderwijs.

Gemeenschap gebaseerd informeel wetenschappelijk onderzoek is onvoldoende onderzocht in Nederland, dit is de context van dit onderzoek. De theoretische en analytische kaders van Figured Worlds en Identity Resources zijn gebruikt om de vorming en het resultaat van de wetenschappelijke identiteit van kinderen te analyseren.

De bevindingen van het onderzoek belichten de relatie tussen gemeenschap gebaseerd wetenschappelijk leren en de betrokkenheid en deelname van kinderen aan wetenschap. Meer specifiek wordt aangetoond hoe de betrokkenheid van families wetenschapsonderwijs introduceert en de wetenschappelijke identiteit van kinderen ondersteunt.

Hoofdstuk twee getiteld "Cultureel relevante/responsieve en duurzame pedagogiek in het wetenschapsonderwijs: theoretische perspectieven en implicaties voor het curriculum" is een kritische beschouwing van de status van informeel wetenschappelijk onderwijs in Nederland, met een focus op de Nederlands-Caribische gemeenschap, die in het verleden weinig aandacht heeft gekregen in het onderwijs gerelateerd onderzoek.

In het theoretische hoofdstuk wordt een argument naar voren gebracht voor het opnemen van meer op cultuur gebaseerde pedagogiek in informeel wetenschapsonderwijs met het programma Roots: Ik ben Science als een concreet voorbeeld. Het hoofdstuk geeft een overzicht van de relevante asset-based pedagogieën, zoals cultureel relevante/responsieve en ondersteunende pedagogieën, en hoe deze worden gebruikt in het gemeenschap gebaseerd STEAM-gerelateerde programma voor jonge kinderen en hun ouders in Nederland.

Waar doet het pijn?

In mijn innerlijke ziel, mijn innerlijke wezen zijn...

Hoe voelt het?

Het voelt als een fractie van wie ik ben: een verlies van mijn zelfvertrouwen en eigenwaarde en mij minder voelen dan.

Juist.

Dat is wat het gevoel minder te zijn dan teweegbrengt: pijn.

Doordat je deze pijn ervaart die je voelt, is het een aanval van nooit goed genoeg zijn in de
ruimte waar jij bent.
De pijn van nooit genoeg zijn, toch?
Nooit genoeg zijn in de ruimte en altijd het tegendeel proberen te bewijzen.
[Je hebt het gevoel een indringer te zijn] die hard werkt om te bewijzen dat jij erbij hoort.
In deze ruimte.
Op deze plek.
In deze ruimte niet alleen als leraar, maar als wetenschappelijk docent.
Altijd bewijzen dat jij, dat ik, in staat ben het te doen.
Ik ben het aan het doen.
Ook probeer ik te bewijzen dat ik geaccepteerd hoor te worden.
Juist.
Dus altijd zoals dit.
Dus dat is wat ik wilde overbrengen, dat dit: elke keer opnieuw waarde proberen te bewijzen.
Dus ik hoor hier, ik moet bewijzen dat ik hier hoor, en ik wil dat andere studenten weten dat zij ook aan de wereld moeten bewijzen dat zij hier horen. (Smith, 2022, p. 138)

Hoofdstuk drie, "Een welzijnsproject: de zoektocht van een Afro-Caribische wetenschapsdocent naar genezing", volgt een auto-etnografische studie van mijn ervaringen als een Afro-Caribische wetenschapsdocent op een openbare school in New York City. Met gebruik van hermeneutische fenomenologie als theoretisch kader, verkende ik de verschillende emoties die ik heb ervaren als een gerasialiseerd ‘ander’ in een overwegend blanke school en samenleving. Door de lens van ervaringsgericht en narratief onderzoek hield ik mijn emoties bij, wat in mijn verhaal een centraal thema is. Het hoofdstuk biedt inzichten uit het leven van een wetenschapsdocent uit Caribische diaspora en het introduceert de Caribische Diaspora Identiteit en de Wetenschappelijke Identiteit voortkomend uit het perspectief van een docent uit de Anglo-Caraïben wonend in de Verenigde Staten. Het vermeldt ook het ontwerp van het onderzoek en het gaat dieper in op de positionering die slaat op de ‘insider/outsider’ status van de onderzoeker tijdens deze studie.

De diaspora
Verspreid...
...Gefragmenteerd
Samensmelten in de ruimtes ertussen
Wij vrouwen van de Caribische diaspora, schrijven ons eigen intellectueel bestaan de wereld in. Terwijl we van frame naar frame gaan, dat is van land naar land, van thuisland naar een vreemd land en naar het land dat eens van mijn ouders was. Uiteindelijk vestigen we in het tussengebied. We interpreteren, analyseren en theoreetiseren de origine waar we vandaan komen. Vanaf die plek daar tussenin kijken we naar binnen, naar achteren en naar voren om te interpreteren, analyseren en theoreetiseren terwijl we... Identificeren als... Gepositioneerd worden als...

Wij zijn als... (2021 Annual NARST Conference, 8 April 2021)

Hoofdstuk vier, getiteld "Ruimtes van Liminaliteit en Hybriditeit innemen: Onderzoek naar de Positionering en Identiteit van een Caribisch Nederlands Meisje in een Gemeenschap Georiënteerd Wetenschappelijk programma." brengt de ervaringen van een jong meisje met Nederlands- Carabische achtergrond naar voren dat in Nederland woont. We volgen het verhaal van een jong meisje genaamd Red, door middel van één etnografische casestudy, om een basis te bieden voor verdere theorieën over Caribisch Diasporische identiteiten en het verband dat ze hebben met de vorming van een wetenschappelijke identiteit. Wat deze twee hoofdstukken linkt zijn de genuanceerde ervaringen van de Caribische Diaspora. De implicaties van dit hoofdstuk, met video-analyse, leveren meer bewijs voor de rol van emoties en doorzettingsvermogen bij het vormen van een wetenschappelijke identiteit en de rol van gezinsbetrokkenheid bij informeel wetenschappelijk onderwijs onderzoek.

Wie ben jij?
Wie ben ik?
Ik ben...

Gehybridiseerd, nooit het een of het ander
Tussenruimtes innemen
Leren op deze plek, de tussenplek
Ik ben...
De afzonderlijke delen die mijn geheel vormen
Ik ben een bouwwerk van identiteiten

Ten slotte is hoofdstuk vijf "Verkennen van Hybride ruimtes, de Vorming van de Identiteit van Kinderen in een Gemeenschap Gebaseerd STEAM-Gerelateerd Programma" een collectieve etnografische casestudy die aantoont hoe hulpmiddelen benut worden in de interacties van hybride online en onderwijs in persoon in de gemeenschap gebaseerd.

Het proefschrift biedt nieuwe theoretische inzichten over hoe kinderen wetenschappelijke identiteiten kunnen creëren wanneer ze de kans krijgen om op persoonlijk relevante en zinvolle manieren met wetenschap bezig te zijn. Ten tweede levert het bewijs van de cruciale rol van gezinnen bij het onderhouden van een wetenschappelijke betrokkenheid. Ten derde laat het zien hoe buitenschoolse instellingen kunnen worden gebruikt om kansen voor mogelijke toekomsten aan te bieden. Ten slotte biedt het een concreet voorbeeld van hoe informeel wetenschapsonderwijs een uitgebreide context is om de wetenschappelijke identiteit van kinderen te bevorderen, waarbij wetenschappelijke betrokkenheid vanuit verschillende achtergronden en contexten wordt gevormd en ondersteund.
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**Professional contributions**

**Smith, T.** “Diversity, Inclusion and Intersectionality in the Classrooms”. Designed and presented workshop at EU project Brighter Futures Stakeholders (UK, Italy, Spain, & Netherlands) Meeting, 10 May 2022.


**Publicity**

Curriculum Vitae

Theila Savannah Smith was born in Jamaica, West Indies, on November 20, 1985. She completed her secondary education at the Bishop Gibson High School for girls in Mandeville, Manchester, Jamaica. She continued on to lower sixth form at Manchester High School before enrolling in The Mico Teachers College (now The Mico University College) where she completed a diploma in Guidance and Counselling in 2006. She emigrated to the United States to pursue undergraduate studies and gained a double degree in Psychology and Biology at Baruch College (City University of New York). Theila completed her second undergraduate degree at Brooklyn College (City University of New York) in Secondary Education with a concentration in Biology (2012-2013). She went on to complete a master’s in science education (2013-2015) at the same institution.

Theila’s professional life is in both the formal and informal education spaces. In 2011, she did a year of national service in AmeriCorps in City Year Seattle-King County where she worked in school in West Seattle. She did another year of AmeriCorps service in 2012 working with an afterschool programme in Yonkers, New York. Later, from 2015 to 2018 she was a licensed teacher working with the New York City Public school system. While working as a science teacher, she was the diversity coordinator and chair of the diversity committee. Over the past five summers (2018-2022), Theila has been an adjunct at Brooklyn College (City University of New York) teaching an undergraduate 6-week Urban Ecology and Eco-Justice course.

In 2018 Theila received a scholarship (B065218) from the University of Groningen in the Institute for Science Education and Communication (ISEC), in the Netherlands to pursue PhD research centred around science identity development in out-of-school contexts. Following her contract that ended on 30 September 2022, she has taken up a position as of October 3rd, 2022, at Florida International University in West Miami, United States, to work with the Dr Remy Dou (PI) and Dr Heidi Cian as a research associate in the STEM Transformation Institute and Department of Teaching and Learning.

Theila is a member of NARST, a global organisation and the European Science Education Research Association (ESERA) Special Interest Group 5 (SIG 5) - Science Identity. She was the NARST Graduate Student Coordinator (2021-2023) and sat on the NARST Board of Directors. Above all else, she is a proud auntie and godparent.