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Children's Experiences and Self-Identification with Science in the Context of an Out-of-School STEM Program

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Abstract

The goal of this case study was to examine how a group of young children in a historically marginalized neighborhood in the northern part of the Netherlands perceived their engagement in an out-of-school, STEM community-based program aiming to enhance young children's interest and self-identification with science. We collected data through semi-structured interviews with eight purposefully selected children and analyzed those through a constant comparative approach and with the use of open coding strategies. The findings revealed specific aspects of the design of the program that were perceived as motivating and engaging: the integrated multidisciplinary approach to exploring scientific concepts and opportunities for active engagement and personally relevant science experimentation. The findings are offered alongside a set of recommendations for the design of out-of-school, community-based programs that aim to support young children's engagement with science.

Keywords: out-of-school science, children, self-identification with science

INTRODUCTION

Humanity faces urgent socio-scientific challenges, such as climate change, sustainability, public health, inequalities that raise new challenges for education in general and science education in particular (Kayumova et al., 2018). Concurrently, reform documents point to a shortage of science, technology, engineering and mathematics (STEM)-trained professionals in Europe, while the demand for STEM workers is rapidly growing (European Commission, 2015). This problem is even more visible in the Netherlands which defines the context of the study, where several interventions already have taken place to increase students' interest in STEM and STEM-related careers. Despite these interventions, Dutch students' enrolment in STEM higher education is lower compared to that of most western countries (OECD, 2011, 2016, 2017). Moreover, recent data show that the 'STEM pipeline' (used to refer to drop-outs) is leaking even faster in the Netherlands, than in other Western countries (van den Hurk et al., 2019). What this means essentially is that not only do fewer Dutch students enroll in STEM studies, compared to students in other western countries, but they are also less likely to persist in STEM-related paths or careers. This is problematic considering the increasing need for STEM workers and calls for research attention and interventions aimed at enhancing the interest and persistence of Dutch students in STEM education. The shortage of STEM workers in Europe has received much research attention in the last few years. Research findings show that interest in STEM seems to decline after age 11 (Kim, 2018; van den Hurk et al., 2019) and provide evidence of the importance of children's early exposure to science at the middle and younger grades to create positive attitudes towards science (Tai et al., 2006). As argued elsewhere, out-of-school contexts are strategically positioned to address these goals in ways that formal school contexts are not in that they provide motivating structures, opportunities to explore science in everyday life contexts that are personally meaningful, and opportunities for more free-choice explorations (Avraamidou, 2014). Similarly, Braund and Reiss (2006) argued that in-school science is too restrictive and limits the authenticity and motivating aspects of the science activities. As they argued, school science should be complemented by out-of-school science learning that draws on the actual world (e.g., through field-trips), the presented world (science centers, botanic garden, zoos,

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Contribution to the literature

- The study explores how a group of young children in a historically marginalized neighborhood in the Netherlands, perceived their engagement in an out-of-school, STEM, community-based program aiming to enhance their interest and self-identification with science.
- The findings of the study showcase the potential role of out-of-school STEM community programs on supporting young children with a migration background to engage with science in personally meaningful ways especially in former colonial settings.
- The findings suggest that a focus on activities that explicitly address goals related to developing an understanding about the nature of science and the work of scientists is warranted for the purpose of enhancing children's self-identification with science.

and science museums), and virtual worlds through information technologies.

Grounded within these theoretical and empirical underpinnings we aimed at exploring how a group of young children in a historically marginalized neighborhood in the northern part of the Netherlands perceived their engagement in an out-of-school, STEM, community-based program aiming to enhance their interest and self-identification with science. For the purpose of this study, we adopt Noam and Shah's (2013) definition of out-of-school science, which refers to programs that offer activities that may or may not align with school curricula, focus on youth development and enriching learning activities, and that can take place in a local community setting, a science center or museum, on weekdays, weekends or during the summer.

LITERATURE REVIEW

Several researchers examined the ways in which different programs and interventions might enhance young children's interest and self-identification with science in out-of-school contexts (Avraamidou & Roth, 2019; Bell et al., 2009). Chen et al. (2014) evaluated two summer programs in which middle and high school students were introduced to various energy engineering concepts such as electric and renewable energy concepts, and engineering designs. A pre-and post-test indicated that both programs improved students' levels of engineering knowledge, interest in learning, participating, and their intention to choose an engineering career. Likewise, Kitchen et al. (2018) examined the impact of high school STEM summer program participation on the end of high school career aspirations among a sample of 845 program participants and 15,002 serving as a control group. Their findings showed that high school students who participated in a STEM summer program were more likely to want to pursue a STEM career.

Bell et al. (2003) examined the impact of an eight-week science apprenticeship program on a group of high-ability secondary students' understanding of the nature of science and scientific inquiry. In contrast with Chen et al.'s (2014) and Kitchen et al.'s (2018) studies, this program did not affect the students' understanding of the nature of science. Moreover, evidence from the large international survey, Program of International Student Assessment (PISA), showed a negative correlation between the number of hours attending after-school science and science assessment scores in many countries (Suter, 2016). A secondary analysis of data draw from the PISA survey, revealed that in most Western countries, the longer students attended after-school science programs, the lower their PISA standardized science test score, but the higher their positive attitude toward future science careers, interest in science, and self-confidence in science (Suter, 2016). These differences in the outcome of interventions are not uncommon while there is no consensus about what types of interventions are successful (van den Hurk et al., 2019). van den Hurk et al. (2019) reported on a systematic review of empirical studies on the effectiveness of STEM-related interventions aimed at increasing the interest and persistence in STEM. They concluded that only a few of the 538 evaluation studies of such interventions, were designed in such a way that the effects are likely caused by the intervention. Moreover, they found that approximately two-thirds of the studies explored summer camps, and the majority of the studies only focused on one or two related STEM fields (van den Hurk et al., 2019). In synthesizing these findings, the researchers pointed to a gap in the literature regarding studies that examine the effectiveness of interventions and programs that aim to increase students' interest and persistence in science.

In attempting to address this gap in the literature, we examined what aspects of a community-based STEM program might shape young children's (6-11 years old) interest and self-identification in science through an exploration of their own perspectives of the program. Framed within identity theory, self-identification is used to refer to how children viewed themselves as competent science persons and would consider specializing in science and following a career in STEM in the future (Avraamidou, 2020). Such an understanding is important because it sheds lights on children's interest, competence, and self-recognition–all critical factors in shaping ideas of who can be a scientist and influencing STEM career choices.

PURPOSE OF THE STUDY

The program that defined the context of this study was designed upon a framework for integrated STEM instruction (Moore et al., 2014) to examine the experiences of young children in the context of a community-based STEM program designed to support students' interest and self-identification with science. The program included activities related to all STEM fields and was organized weekly, every Saturday morning in a youth setting. Moore et al. (2014) defined integrated STEM as "an effort to combine some or all of the four disciplines of science, technology, engineering, and mathematics into once class, unit, or lesson that is based on connections between the subjects and real-world problems" (Moore et al., 2014, p. 38). According to this framework, a STEM integration learning experience is of high quality when it includes six different aspects:

1. motivating and engaging context,
2. an engineering design assignment,
3. opportunities to learn from failure,
4. mathematics and/or science content,
5. student-centered pedagogy methods, and
6. opportunities to develop skills in teamwork and communication.

The study follows a case study paradigm, which allows an in-depth exploration of the participants' experience at the program. Such an in-depth exploration can be used as input for the design of interventions which aim to increase young children's interest and self-identification with science. The research questions that guided this study are the following:

1. How did a group of young children perceive their engagement in a community-based STEM program?
2. How did a group of young children self-identify with science throughout their engagement in an out-of-school, community-based STEM program?

METHODS

Context

The study is part of a larger research project that examines the ways in which out-of-school, STEM community-based programs might serve as a means for disrupting monolithic conceptualizations of the nature of science and existing exclusionary narratives of who is considered a legitimate producer of scientific knowledge (Smith et al., 2022). This is especially important in former colonial contexts, such as the Netherlands which, unlike other European countries lags behind in processing its colonial past across educational institutions (Wekker, 2018). Hence, the out-of-school program, theoretically framed in culturally-relevant/sustaining pedagogies, aims to serve a group of Dutch-Caribbean students.

The larger research project comes as a response to the urgency and value of engaging with a set of underexplored questions that relate to issues of colonialism, power, and racism in science education in [country]. Examples of such questions include the following: Who is allowed in science? Who is recognized as an insider/outsider in science? Who is recognized as a successful science learner and who is made vulnerable? What kinds of identities are deemed in/outside of place in school science? (Avraamidou & Schwartz, 2021). Essentially, what the out-of-school program aims to do is to provide young children that have historically been constructed as outsiders in science, a space for dreaming of possible selves and possible futures, through opportunities to engage in personally-meaningful, culturally-relevant, moment-to-moment sense-making in equitable and agentic ways.

The program provided children and their families with opportunities to engage with science in a familiar and easily accessible space. The topics selected were drawn out of the national curriculum as well as children's interest that we found out about through interviews we had with the families prior to the design of the program. All sessions included design of investigations around a driving questions through the use of hands-on simple experiments and materials. Through the sessions, the children explored various scientific concepts ranging from plate tectonics and earthquakes, to forces, motions, air, to friction. For example, the hovercraft science experiment project engaged children in exploring the concept of friction. The children were provided with a balloon, a cap and blue-tac and followed the following steps:

1. **STEP1**-Roll the Blue-Tac into a sausage shape and press it down onto the CD, in a circle. Push the bottle top down onto the CD so that it sticks to the CD with no gaps for the air to escape.
2. **STEP2**-Blow up the balloon pretty full and then twist the bottom round several times (so the air does not all come out while you are attaching it to your hovercraft base!).
3. **STEP3**-Stretch the balloon over the bottle top, untwist the balloon and you are off. Try pushing your hovercraft gently and watch how far it glides!

In engaging in these activities, the children essentially collected data through their own designs and experimentation to respond to the driving question: Why do hovercrafts glide so effortlessly?

The program was initially set up as a 20-week program, but due to the COVID-19 pandemic it had to stop after five weeks. The first session was the open day and the next four sessions were dedicated to making a hovercraft, a submersible, a windmill, and a computer game. In each session, general science lessons were given. For example, during the submersible session, the

Table 1. Participants

Participant (age)	Gender	Ethnicity	Background
Ava (10)	Girl	White	Dad is an immigrant.
Keon (10) & Jamar (8)	Boy (K) Boy (J)	Black	Mom is a midwife with a private clinic. Dad is an overnight shift worker.
Rosa (11)	Girl	Black	Aunts share custody, aunt is multilingual, aunts grew up in St. Maarten.
Leron (10)	Boy	Black/ Afro-Caribbean	Mom is an immigrant who is residing for 20 years, husband works, stay-at-home mom.
David (8) & Kendell (5)	Boy (D) Boy (K)	Afro-Dutch	Mum is a special education teacher. Works with children with disabilities.
Dory (10)	Girl	White	Mom stays at home with the children. Dory has one older sister.

participants considered how the size of a propeller influences the speed of a submersible due to resistance. Each session took about 90 minutes. During the sessions, multiple volunteers organized the lesson and guided the children through the science investigations.

Research Design and Participants

The study follows a case study paradigm with the case being defined by a group of eight purposefully selected young children (Merriam, 2009). These eight children were all participants in the program and they were purposefully selected to achieve diversity in terms of gender and social positioning: ethnic background, socio-economic status, school achievement, and gender. This research design allowed to take a holistic, comprehensive approach, which is necessary to create a deeper understanding of the experiences of the participants. Even though the participants were treated as one case, in analyzing the data we compared and contrasted the participants' experiences for the purpose of gaining an understanding of how each of them perceived their engagement in the program and how their engagement shared their interest and self-identification with science. Table 1 provides an overview of the participants, their ethnicity, and background.

Data Collection and Analysis

The data were collected through one-to-one interviews with each of the participants. The interviews were semi-structured and focused on the participants' experiences in the context of the program. The interviews were conducted over the phone because of a national lockdown and related regulations that did not allow for visits, and took place two weeks after the final session of the program. The interviews were conducted in Dutch as per the participants' request. In three cases the participants were interviewed together with their parents. The interview protocol that was used was used in previous related research with young children in a different context (Avraamidou, 2013). It included question a combination of close and open-ended questions such as the following:

a. Which sessions did you enjoy the most? Can you explain why?
b. What do you think scientists do? Do you see yourself as a scientist in the future? Why/why not? What careers interest you, why?
c. What did you like the most about the program?

We selected to interview children in the presence of their parents because of the young age of the children and in attempting to make them more comfortable. The interviewer directed very specific questions at either the participant or the parent to ensure the participants answered the questions and not the parents. In some cases, the participants actively asked for help answering a question to their parents. Moreover, the parents were able to help the interviewer by repeating the question to their children or asking their children to elaborate more on their answer. During the other three case studies, the interviewer was able to ask the participants a few questions and then afterward ask the parents some additional questions. The questions directed at the parents were mostly to confirm given answers from the participants and to collect additional information on the engagement participants had, which became evident through for example conversations parents remembered having with the participants at home.

To analyze the data, we used we vivo, line-by-line coding techniques, using quotes and words from the participants as codes (Merriam, 2009). First, the first author carried out the analysis on independently. Following on that and in collaboration with the third author who is an expert in qualitative research organized the open codes into categories such as school experiences, attitudes, emotions, roots versus school, interest in science, understanding of science, etc.

To establish trustworthiness, we used triangulation strategies to increase the internal validity of the interview protocol, while all three authors engaged in the data analysis and interpretation. In addition, children's responses were triangulated with input collected from parents as well as the second author's observations from her dual role as an instructor and researcher. The second author, was in close contact with the parents from the conceptualization until the end of the project was heavily involved in the process of data collection and analysis because of her unique insider's positioning. The three researchers met multiple times to

Table 2. Summary of the experiences of the participants at the program

Participant (age)	Differences between the program & school	What is science?	Future plans
Ava (10)	Doing more experiments Teachers are less strict & more available for questions & support Opportunity to work with other children	Doing experiment Trying things out & see what works & what does not work Trying something else if it does not work	Would like to visit a university & meet scientist Might be interested in doing something science-related when she grows up
Keon (10) & Jamar (8)	School is boring, the program is fun. At school, they just have to write stuff down, at the program they get to do stuff	Experiments & stuff (K) Like aliens perform experiments on humans (J)	Would like to make a purple drink, using fire, like a fried scientist (J) Visiting a scientist's lab (K) Would like to do more science-related things, as long as it is like science in program (K) Wants to become both a construction worker & a chef (J)
Rosa (11)	At the program more technical things & programming are discussed At the program students are doing more stuff, instead of just learning The teachers at the program explain things & help students as well, while teachers at school only explain a little bit & do not offer much support	Not discussed	Would like to make a robot Might be interested in pursuing science, as long as everything is explained well & she understands everything
Leron (10)	The program is shorter At school, they work on multiple subjects not just science At the program there are more teachers to ask questions to	Did not know how to define science	Not sure yet if he wants to do something science-related or not
David (8) & Kendell (5)	They do not perform experiments at school like the program	Not discussed	Not discussed
Dory (10)	Toots provided opportunities to discover things for herself, while at school she gets a book with the answer	Trying things out & see what works & does not work	Would like to visit a university & meet scientist Might be interested in pursuing science but is also thinking about becoming an illustrator

discuss the coding and interpretations and discussed disagreements until consensus was reached.

Limitations

The limitations of this study are connected to the small number of participants and the short duration of the program. Although eight participants provide a good opportunity to gather in-depth data and perform a deep analysis, no generalizations can be made based on this research. However, these participants represent only 1/3 of the total number of participants of the program. In terms of duration, the program was designed as a twenty-week program, but due to the COVID-19 pandemic, it was cut down to only five weeks. This has limited the number of sessions in which the children participated, and that is why we treat this study as a pilot study which can inform the design of research studies with a larger number of participants.

FINDINGS

This section includes a portrait of each participant. These portraits provide summaries of the experiences of the participants as those were reflected in the interviews. Table 2 and Table 3 provide an overview of the experiences, categorized in general themes that have been discussed in all the interviews.

Ava

Ava's father was among the first parents sign up for the program. Ava is ten years old and has one older sister. Her father is an immigrant to [country] and does not have a good grasp of the Dutch language, but Ava does. Whenever Ava visited the program, she was always engaged with the material, smiled, and acknowledged everyone, but she was not much of a talker. Ava attended two sessions out of a total of five sessions. She visited the introductory day where she participated in various activities such as building towers with spaghetti and marshmallows and making slime. During another session, she made a windmill. When asked about her experiences in the sessions she attended, she said:

> A: I thought the program was fun because you learn things and it is super nice to make things. And you also learn a little English.

Table 3. Summary of the participants' experiences

Participant (age)	Views about the program	Attended experiments	Favorite experiment & the reason why
Ava (10)	Learned new things Found it nice to make things Learned a little English	Introductory day Windmill	Windmill, because she enjoyed trying out her windmill & see if it worked or not
Keon (10) & Jamar (8)	He could do Scratch (L) He could learn things (L) Activities were fun (K) Could learn new things (K)	Introductory day Hovercraft Scratch	Scratch (J) Building marshmallow tower (K), because he got to take all the marshmallows that he used home, to eat them
Rosa (11)	Learned new things	Introductory day Hovercraft Submersible Windmill Scratch	Scratch, could not explain why
Leron (10)	Saw new things every week Did new things every week Opportunity to see if he would want to do science in the future	Introductory day Windmill Hovercraft Scratch	Windmill or Scratch, could not explain why he liked Scratch
David (8) & Kendell (5)	Learned new things	Introductory day Hovercraft Submersible	Making slime (D & K)
Dory (10)	Teachers let her do her thing	Introductory day Hovercraft Submersible Windmill Scratch	Hovercraft, because she learned the newest things form it

Ava stated that her favorite activity was making the windmill because she enjoyed watching if her windmill worked or not. She described the assignment, as follows:

> A: First you had this ice scream stick and you had to glue something on it. And on top of that, a little motor was placed, which would make the light go on [when the windmill was turning].

The first time Ava attended the program, she was accompanied by her father. However, shortly after they arrived, Ava asked her father to go home so she could do it alone. The second time Ava attended, she went all by herself since it is nearby of their house and she wanted to do it herself, as her father explained. She explicitly said she wanted to go on her own the second time. Her father offered two possible explanations about this: either Ava thinks parents shouldn't be there, or she has reached an age where she wants to do something interesting without her parents. Nonetheless, when Ava got home from the program, she shared her experiences with her family by explaining to them what she made and how she made it. When Ava compared the program with school, she stated that was more fun:

> A: The program is more fun than school because you are doing more experiments and we don't do that at school. We learn math, grammar, and spelling. The teachers are a bit different as well. At school teachers are stricter and you do not get to ask questions and things like that. At the program you can work with others and things like that.

Ava's father recognized this answer from his daughter and explained that it was different in various ways for Ava. First of all, she didn't know any of the kids that were there. Second, she got to hear and learn a bit of English. Third, she enjoyed the experiments, which she never performed at school.

When Ava was asked what kind of activities she would like to do in the future, she reacted enthusiastically to the idea of visiting a university and meet scientists. Her father thought that Ava would enjoy some more complex experiments like the windmill, instead of simple and shorter experiments that she engaged in during the introductory day, or perhaps experiment outside. When asked to define science, Ava defined science as doing experiments:

> A: You know, just trying things out and see what works and what doesn't work. And if something doesn't work, you change something, and afterward, it maybe does work. It is all about examining things and trying to figure out how something works.

The two-session that Ava attended did not seem to have an additional impact on her view about science. She explained that she already liked science and still liked it after the sessions at the program. She expressed that she might be interested in doing something science-related when she grows up.

Keon and Jamar

Keon (8) and Jamar (10) are two brothers who visited out-of-school science activities at the program three times out of the five sessions. Their mother was born in St Martin and moved to the [country] to pursue a degree and career in nursing. They visited the introductory day where they participated in various activities such as, in their words, riding on a smoothie bicycle (a bicycle on which you can make a smoothie), building a marshmallow tower, counting jelly beans, and making slime. During the other two sessions, they made a hovercraft and used the software Scratch as part of a session that focused on programming. When asked about their experiences in the sessions they attended, they said:

> L: I liked the program because we could do Scratch which I enjoyed. And, I learned new things.
>
> K: And the activities were fun. And we could learn new things like with balloons and DVDs.

Jamar stated that his favorite activity was the use of Scratch. As he explained, he used Scratch in the past at school during 'free learning hours'. These are hours in primary school in which students get the opportunity to spend time on a subject or topic of their choice without having any kind of assessment. Even though he perceived himself as not being good at it, he still expressed he was excited about using it again and he described the assignment as follows:

> L: We had to make a game with a little arrow and all different kinds of balls. You had a green one, a yellow one, a blue one and a pink one. And you had to touch all of the balls with the arrow to get points. But the red ball would kill you. And you had to make the game yourself by programming all these things. All the balls and the arrow.

Keon's favorite activity was building a marshmallow tower, partially because he got to take home all the marshmallow that he used, to eat them. Another activity that Keon recalled was the one where they had to build a hovercraft. He described his engagement in the experiment, as follows:

> K: We had a DVD and a glue gun and a bottle cap.
>
> L: And a balloon!
>
> K: And the bottle cap; you had to glue it to the DVD. We had to blow air into the balloon and then it started moving a little bit because of the balloon. Because the air would go out of the balloon.
>
> L: It would float.
>
> K: But mine did not work.
>
> L: Mine either, but it was the best because it moved a little…but, not so much.

When they compared their experiences at the program to their experiences in school, Jamar and Keon described the school as 'boring' and a place where they 'just have to write stuff down. When describing the program, they referred to it as 'fun' and a place where they could do stuff, emphasizing the hands-on nature of the activities. Their mother confirmed they enjoyed the program more than school because they always came home very enthusiastically and talked about the experiments they did that day. When asked what kind of experiments they would like to do in the future, Jamar enthusiastically shared his desire to 'make a drink, using fire, like a fried scientist'. Likewise, Keon shared he would be interested in visiting a lab, as long as it is owned by a 'weird scientist'. They elaborated on their images of these 'weird' and 'fried' scientists:

> I: So 'fried and weird' is that your image of a scientist? And in this image, is the scientist a man or a woman?
>
> L: The weird scientists are men. With white hair…like, he was struck by lightning.
>
> K: I thought scientists can only be men. Like Einstein! They are more suited to be scientists because they are stronger and smarter than women.

When asked to explain what science is, they said:

> I: Maybe this is a bit of a hard question, but can you explain what science is?
>
> K: Experiments and stuff.
>
> L: Like for example aliens! There are aliens and they search for humans and do all kinds of experiments on them, with needles and other things like medicine.
>
> I: As you see in the movies? That alien's test on humans?
>
> L: Yes.

After defining science, they shared their view of science:

> L: Science is often a bit boring: you do not always do it a fun way. Like when you are only doing a lot of similar small experiments. It was more fun at the program.

Keon expressed similar mixed feelings about science when I asked him if he would like to perform some science experiments again in the future:

> K: It depends…if it would be something like the program, then yes. But not when it is only doing experiments with tubes as measuring cups as you see in the movies. With all those purple fluids. I would not enjoy that.

This extract from the interview illustrates how the two brothers have different interests since making purple fluids would be an experiment that Jamar would very much enjoy as he earlier described. Another factor that might have attributed to why Jamar would like to make a drink is because he aspired to become a construction worker and a cook when he grows up. As he stated, when he grows up, he wants to build his own restaurant and work there as a chef. Keon didn't have any future jobs in mind yet.

Rosa

Rosa's family is from St. Martin. Rosa is eleven years and will be transitioning to high school next year. During the program, she was very quiet, however, she showed up every week and had invited three of her friends to join the program too.

Rosa visited five sessions of the program. She recalled participating in various activities she described as making a boat, a hovercraft, riding on blender bicycles, making a spaghetti tower using spaghetti and marshmallows, and making slime. Her favorite activity, as she stated, was the use of Scratch. She described the assignment, as follows:

> R: I had to program a ball game with Scratch. If you touched the red ball the game would be over and every time you touched a ball with your arrow, you would get points and you could decide how many points.

When she elaborated on why she enjoyed the program, Rosa explained that she enjoyed learning new things, like making the hovercraft and learning how to program. When asked if there were any differences between the program and school, she identified multiple differences:

> R: The program is very different than school. Because at school we learn math, grammar, spelling and at the program you learn more technical things and programming. At the program we do more stuff, instead of just learning. The teachers are different as well: they explain things, and they help you as well. While at school, they explain only a little bit, and then afterward you have to figure it out yourself.

When she was asked if there were any types of experiments that she would like to do at the program in the future, she shared her desire to make a robot. This desire originated from seeing robots on TV and thinking it would be fun to have her robot, as Rosa explained. Looking back at all the activities she participated in, she concluded that what she learned most was how she could work together with others and how she could make things like she made the hovercraft and boat. Regarding her self-identification with science, she stated that as long as she receives enough explanation and understands everything she has to do well, she might be interested in doing science when she grows up.

Leron

Leron's parents are immigrants from Jamaica, however, emigrated to [country] from the US. Leron appeared shy during the program and performed most of the activities while gaming, which he loves, on his phone. He often joined the table with the other boys and actively engaged in group conversations. Leron (10) attended four sessions. He visited the introductory day, during which he performed all kinds of simple experiments. In addition, he participated in the sessions where he had to make a windmill, a hovercraft and use the software Scratch as part of a session that focused on programming. When I asked Leron about his experiences in the sessions he attended, he said:

> L: I enjoyed the program because every week we saw new things and could do all different kinds of stuff and we could also think about like maybe in the future I would like to do science.

When Leron was asked which of the sessions he would choose as his favorite, he needed to think for a while, and finally stated that his favorite activity was either making the windmill or coding with the software Scratch. Leron's mother thought this choice made sense because according to her, he is a 'computer type', meaning that Leron is really into computers and gaming. Leron explained that he used Scratch once in the past at school, but did not do much during that lesson. He described the assignment of the Scratch session:

> L: There were different kinds of balls. And you could just… sort of making a ballgame.
>
> I: And how did the software work? How did you code the game?
>
> L: There was a list with things you could use, like paths, bees, and whatever [referring to the Scratch session at school]. And you had to build a few paths… and when you pressed the green flag [referring to the green play button in the Scratch program], the game starts.
>
> I: And were you supposed to think of the rules for the game yourself?
>
> L: No, they had written the rules on the board and they showed examples of how they programmed

> the game. But Eli [a friend of Leron who also participated in the Scratch session] made a whole different kind of game, with better movements. So, I asked if I was allowed to do the same as him, and I was! But the balls did not do much anymore. I just turned it into a massive thing!

Besides the session with Scratch, Leron also had clear memories regarding the hovercraft session and he described his engagement, as follows:

> L: The hovercraft was just a cd and helium would get it up.
>
> I: Did you put helium in the balloon?
>
> L: No, we did not. But you would blow air in the balloon until it is full. And then we took a bottle cap of the bottle and punctures little holes in it, and then we attached the bottle cap to the balloon. So first we blew the balloon and then we put the cd on it. There were all kinds of steps in between, but yeah. And then you had to… then we had to squeeze the balloon, to prevent it from going in the air already and then put it on the table…
>
> I: And did the hovercraft float?
>
> L: Well, no… maybe… there was one group who managed to float it for one second.
>
> I: Your group did not?
>
> L: Only for half a second.

When Leron was asked to explain what science is, he found it hard to answer. After providing him with a short definition of science, he said that he knew partially what science was. Moreover, when asked if he felt like he understood the concept of science better after the activities at the program, he answered:

> L: A little bit, because the more I do stuff, and repeat stuff, the more I will remember it. When something repeats and repeats, it will get stuck in my head.

At the time of the interview, Leron stated that he had not thought about his future studies or career.

David and Kendell

David and Kendell's mother is a teacher. They live far away compared to the other participants and had to rely on other family members, such as their aunt or uncle, to drop them off at the program. David (8) and Kendell (5) attended three sessions together. They attended the introductory day, during which various activities were organized such as making slime and riding on smoothie bicycles, which are bicycles that will make a smoothie when you ride on them. During the other two sessions they attended, they made submersibles and hovercrafts. David and Kendell both stated that the activities were fun. Furthermore, they stated that making slime during the introductory day was their favorite activity, but neither of them could remember how they made it. David recalled another session at the program during which they built a hovercraft. He described the assignment, as follows:

> D: The balloon could float. We had a little block and we put that on a cd. And then we had to put a balloon on top of it and we had to go outside to see if it would float or not. And the balloon floated a little bit.

David and Kendell's mother confirmed that her sons enjoyed the program. She would often ask questions about the activities her sons joined that day and, as she explained, her sons always answered enthusiastically and kept thinking about things, like how the hovercraft could float, during the rest of the week. Moreover, her sons showed the slime and hovercraft that they made to their families which they often visited right after leaving the session.

When asked what kinds of experiments they would like to do in the future, they did not have an answer. Their mother explained that David and Kendell both enjoy playing outside and suggested that they might be interested in performing experiments outside, in nature, looking for little animals for example. When David and Kendell compared the program to school, they stated that the experiments they performed during the out-of-school science activities at the program are different from what they do at school, and made them learn new things. They both provided this as the reason why they prefer the program over the school. However, they explained that they did make slime once before at day-care, but not at school. Their mother explained how she noticed that her sons kept thinking about the experiments at the program for the rest of the week, which made her belief that David and Kendell might be interested in pursuing science when they grow older:

> I: Do you think David and Kendell might want to do something science-related in the future?
>
> N: I think so. During the week they sometimes talk about their experience at the program: how did that go? How did that work? Kendell was interested in the smoothie bicycles. He was intrigued and wanted to know how the bicycle could make the smoothie.

According to his mother, Kendell did not have a clear view of what science is. When he talked about the experiments at home, he talked more about playing, instead of examining or discovering, as his mother explained. David on the other hand, who is a bit older, defined science as involving quite a lot of experimentation, which might imply the fact that we developing understandings about the nature of science.

Dory

Dory loves science and usually does experiments at home, as she shared in the interview. For example, she did an experiment with the 'egg in acid' project for school. She also played the piano and skated with her older sister. Her mother is also a beekeeper. Dagmar was very active at the program, chatted happily with her table no matter where she went and answered questions very well, and communicated both in English and in Dutch. Dory (10) visited all five sessions. When asked about her experiences in the sessions that she attended, Dory said:

> D: I liked the program, because the teachers let us free. We were allowed to do different things than the assignment. For example, during the session where we had to make a hovercraft, our group wanted to make a hot air balloon. And we were allowed. In the end there wasn't enough time to do it, but I thought it was nice that they let us do our own thing.

Dory's mother, confirmed that Dory enjoyed the program a lot. She explained that Dory was always looking forward to going to the program, was challenged, and always came home with a lot of energy and enthusiastic stories about the activities. Moreover, Dory's mother expressed that she thought the program was a good opportunity for Dory to learn more about science, since she, in her words, 'is not a science person', and she thought that all the female teachers at the program could be nice role models for her daughter. Dory was asked to elaborate on the assignments that she got during the session and started with describing the assignment of the hovercraft:

> D: We had a CD, a balloon, and a bottle cap. In the bottle cap we had to puncture little holes. And I don't know any more how, but had to attach the balloon to that. And then, under the bottle cap, we glued a cd. And then you were supposed to blow air in the balloon, attach it to the bottle cap and put in on the ground. And then it was supposed to float a bit above the ground. And it worked! Mine floated like two millimeters above the ground.
>
> I: Impressive! And do you know why it floated?
>
> D: Yes, because there was too little room for the air in the balloon. Hence, due to the pressure inside the balloon, the air is pushed out. And because of the bottle cap with the little holes, the comes out a little bit, but it cannot go anywhere, because it is standing on the ground. But the balloon gives so much pressure, that the air is getting between the ground and the bottle cap, which makes it float.

Then she moved on to the session in which she made a submersible. She tried to describe the assignment of this session as well, but she couldn't remember it in such detail. However, she recalled the conclusion that was drawn from that session:

> D: I participated in a contest to see which submersibles went faster and we concluded that the red propellers were faster than the yellow ones. Because those were smaller and experienced less resistance which made the boat go faster. Just like when you would cycle faster, when you make yourself very small when cycling in headwind. You catch less wind. And that happens with the propellers of the submersibles in the water too.

Besides the sessions in which she made the hovercraft and submersible, Dory also attended the sessions during which they made a windmill, used the software Scratch to program their own game, and the introductory day during which various activities were organized. From all the activities, she stated that making the hovercraft was her favorite activity, because, in her words, she learned the most from it:

> I: Which experiment do you think was your favorite?
>
> D: I think it was the hovercraft, because I learned the most from that one. I already knew about that stuff of resistance [referring to the submersible session]. But of the hovercraft… I did not yet know that… I did not yet know that if you would turn the balloon first, and then would let it go, that the hovercraft would make a very little jump first, which would make the hovercraft float higher above the ground. I did not know that, and it was a lot of fun to discover that.

When I proposed several activities to do in the future, Dory very enthusiastically reacted to the idea of visiting a university and meeting scientists. When she compared the program to school, Dory stated that although she really enjoyed school, she enjoyed the program even more, because she got the opportunity to discover things herself, while at school she had to work in a book, which gave her all the answers, too.

When asked her to explain what science is, she was not able to. However, when the questions were rephrased to 'what do you think of when you think about science?' she answered that she thinks about 'trying things out' and 'perhaps things go right, perhaps they go wrong'. In terms of the future, Dory does not know yet what she wants to do when she grows up.

Perhaps something science-related, but she explained she is also seriously considering becoming an illustrator.

DISCUSSION

Experiences That Stood Out

The findings illustrate that all participants perceived their engagement in the program as a positive experience. All participants consistently shared positive feelings and memories by referring to the hands-on nature of the program and the various learning opportunities for new and different skills, such as programming, engineering and in some cases even a bit of English. This illustrates how the participants recognized the learning opportunities within the program. The participants engaged well with the materials they had to use during the activities. While describing their activities and experiences, every participant focused on the engineering part of the assignments: the phase where they had to build for example a hovercraft, a submersible or a windmill.

As it became evidenced in the interviews, the participants were able to recall all the activities they engaged in, the kinds of materials they had to use for the experiments, often low-key house-hold objects, such as wooden planks, lime, bottles, bottle caps, balloons, CDs, etc. Even with the assignment where the participants were tasked to program a game using the software program Scratch, the participants seemed to have a vivid memory of the 'objects' they were able to use for their game: balls with various different colors, arrows, points et cetera. This provides evidence how the participants engaged well with the materials they had to use.

The findings reveal that all participants emphasized the hands-on nature of the program and the opportunities they were provided to engage in science investigation. When they were asked to describe the assignment, all participants, except for Dory, shared a step-by-step approach, describing what they had to do. Not only does this show that the hands-on nature of the program was the most memorable aspect of the program, but the in-depth memories the participants have about the assignments add to the evidence of a strong engagement from the participants with the activities. Wieselmann et al. (2019) found similar findings when examining the experiences of thirty female students at an out-of-school science program. Their participants all consistently reported the hands-on learning opportunities as key to their enjoyment too.

There was no consensus among the participants about which activity was the ultimate favorite, which illustrates how each participant experienced the activities differently and probably filtered those through their personal interests and background experiences. Dory and Ava chose their favorite experiment based on the session where they had learned the most, while David and Kendell picked slime because they enjoyed making it and playing with it. Leron, Jamar, and Rosa all choose the session where they used Scratch to program their own game, but none of them could tell what it was that they liked about programming. These findings illustrate how the participants all valued their perceived engagement in different ways, some making learning the most enjoyable aspects, while others choose playing as most important.

More evidence about the participants' perceptions of their engagement in the program lays within the conversations they had with their families after attending a session. They confirmed that the children would go home after the session and share with enthusiasm what they made and how they made it. This kind of evidence supports our findings that the project had an impact on supporting the participants' engagement with science and enhancing their interest in science as well. With the exception of Leron, the participants unanimously agreed that they preferred the out-of-school program over the school. They described their experiences as more engaging. The participants emphasized various pedagogical differences between the program and school. They emphasized the hands-on nature of the activities and the focus on science and engineering instead of mathematics and grammar which are emphasized in the formal school curriculum. Furthermore, they mentioned the program provided them with opportunities to work with other children, their parents, to learn from their own mistakes, and to pose their own questions. Dory also emphasized the inquiry-based approach, which allowed her to discover things for herself. These findings contribute to existing research findings suggesting that integrated STEM instructions can serve as a strategy to enhance elementary students' interest in science and especially in out-of-school contexts (Wieselmann et al., 2019).

Understandings of the Nature of Science and Self-Identification with Science

The findings suggest that the participants have a very basic understanding of science as a discipline that involves a lot of experimentation. None of them appeared to have a strong desire to engage with science but they were not negative towards science either. Most participants defined science as 'experimenting', 'trying things out and change something if it doesn't work, and related these characteristics to their own experiences at the program. Ava, for example, explained how she enjoyed trying out if her windmill worked or not. Similarly, Dory explained how she experimented with different propellers to find out which propeller would make her submersible go the fastest. These definitions and associations with science illustrate that the participants have a baseline understanding of the nature of science. This is in agreement with studies that found that young children generally give quite informed statements regarding the nature of science. Brandes (1996) investigated young children's ideas about science, by asking students from various grades 'what is science?' He showed how the frequent mention of experiments as science activities showed a shift from the 'mix things and see what happens' view of younger children toward a view of science as an enterprise focused on increasing our understanding of the world (Brandes, 1996). Like in the present study, some of his participants explicitly described science as explaining things and finding out how things work. This is in agreement with the study carried out by Cakici and Bayir (2012) investigated the effects of using role-play on children's views of the nature of science. They surveyed 18 children, aged 10 or 11, and found in their pretest that already 39% of their participants knew science is about obtaining knowledge throughout experiments. Likewise, Bartley et al. (2009) investigated the experiences of thirteen fifth-graders at an informal, university-community-based, science educational afterschool program. They present quotes from participants in which they associate science with experimenting, similar to the quotes from this research.

The brothers Keon and Jamar were the only two participants who shared more stereotypical images of science and scientists. They described scientists as 'weird', 'white men' and 'white, fried hair' and associated science with making 'purple drinks' and 'exploding things'. Jamar's and Keon's images of scientists and science are well in line with Brandes (1996) findings. They are the two youngest participants and seem to associate science more with 'mixing and exploding things', than the older participants do. Moreover, such stereotypes are very common among young children. Newton and Newton (1992) already found in 1992 that stereotypes about science and scientists start at the age of six. Even nowadays, scientists are still portrayed as middle-aged men, wearing a laboratory coat, glasses and working in a laboratory (Avraamidou, 2013b; Cakici & Bavir, 2012).

However, in the cases of Keon and Jamar, these stereotypes do not seem to have affected their image of science negatively. Their stereotypical images appear to be a reason to engage in other science activities, like making it fun to see a lab from a 'weird scientist' and perform experiments as 'fried scientists' do. Overall, the participants did not strongly identify with science. Some stated that they might pursue science when they grow old, while at the same time exploring other options such as professional gamer, illustrator, chef, construction worker et cetera. However, none of the rejected the possibility of studying science or following a STEM career.

CONCLUSIONS & RECOMMENDATIONS

The overall goal of this study was to examine how a group of children perceived their experiences at an out-of-school, community-based STEM program and how their engagement shaped their self-identification with science. To explore if and what specific aspects or features of the program influenced their engagement and consequently their interest in science, we examined their experiences through an integrated STEM instruction framework. In general, the findings of the study suggest that the program was perceived as a positive experience by the participants who engage in the activities with great enthusiasm. All of them had stated that they preferred engaging with science in the community settings instead of school science explained this by highlighting several integrated STEM instruction aspects. However, the practical nature of the program as well as ample opportunities to engage in experimentation with science appeared to have enhanced the participants' engagement the most, making it according to this study one of the most important aspects for integrated STEM instructions as a strategy to increase children's STEM engagement. Further research to explore the influences of out-of-school science activities on the children's views of science and their desire to pursue a STEM career is needed to identify the design components of such programs that might support them in developing such understandings and aspirations. While doing so, researchers ought to design their studies in such a way that the possible effects are likely caused by the intervention and not any other circumstances, like van den Hurk et al. (2019) concluded about the majority of empirical studies aimed at increasing the interest and persistence in STEM.

Concluding, the aim of this case study was not to draw generalizable conclusions, but instead to provide insights of how a group of young children in a historically marginalized neighborhood in the Netherlands perceived their engagement in an out-of-school, community-based program aiming to enhance children's interest science. The findings can be used as input for the design of larger-scale studies and interventions which aim to increase young students' interest in STEM. At the same time, the findings imply that a stronger focus on activities that explicitly address goals related to developing understandings about the nature of science and the work of scientists might be needed for supporting children's self-identification with science. Therefore, the following recommendations are offered for the design of interventions that aim to increase young children's interest in STEM:

a. Inclusion of the six aspects of the integrated STEM instruction framework, with extra attention on the engineering design assignment;

b. Inclusion of specially designed activities that explicitly support young children's self-identification with science; and
c. Providing opportunities to meet and work with scientists for the purpose of gaining an understanding of the diversity of STEM careers as well as the nature of scientific practices.

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