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Article

Children's Augmented Storying in, with and for Nature

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Abstract: Drawing on a relational ontology and scholarship of new literacies, we investigate the materiality and performativity of children's augmented storying in nature. Our study is situated in a Finnish primary school in which a novel, augmented reality application (*MyAR Julle*) was utilized as a digital storytelling tool for children ($n = 62$, aged 7–9), allowing them to explore, interact, and imagine in nature and to create/share their stories. The data corpus consists of their narrations of their augmented stories in nature, their augmented story artefacts, and video/observational data from their construction of such stories in nature. Narrative analysis reveals how the children's augmented storying in nature was performed through playful, affective, and sensuous, identity, cultural, and critical literacies, which were imaginatively constructed into being at the nexus of their sensed reality and fantasy. These literacies make visible human–material–spatial–temporal assemblages during which the children played with/through the augmented character Julle, felt and sensed with/through Julle, and re-storied their experiences, cultural knowledge, and identities with/through Julle. They also engaged in critical thinking with/through Julle. The study contributes to knowledge on the meaning of materiality in children's storying in, with, and for nature and the educational possibilities of augmented storying for children's (eco)literacies.

Keywords: augmented storying; children and nature; pedagogy; new literacies; relational ontology; eco-literacy

1. Introduction

Children's opportunities to interact with nature are increasingly becoming threatened due to urbanization, digitalization, and changing lifestyles [1,2]. Such trends—if not carefully attended to by policy and educational practice—are likely to lead to shifts in children's relationship with nature, with negative consequences to their pro-environmental behaviors. How children are afforded educational opportunities to interact and develop their relationships with nature in the midst of changing societies, technologies, and ecology are pressing issues for today's education. Also, how can digital technologies be harnessed in education in sustainable and ethically responsible ways warrants more research attention. At the same time, studies indicate that many children and young people feel that they are not often listened to in relation to environmental or sustainability issues [3,4]. Hence, there is a need to create new entry points for participation that empower children in communicating their views, experiences and concerns in relation to nature. This includes creating pedagogies that elevate children to the roles of investigators, authors, and change agents rather than being mere receivers of adult information and advice on the natural world [5,6].

In this study, we respond to the need to reconsider how educational opportunities are created to enable children to interact and relate with nature. Specifically, drawing on relational ontology and scholarship of new literacies, we will investigate the educational potential of children's augmented

storying in nature. Our study is situated in a Finnish primary school in which a novel augmented reality (AR) application, *MyAr Julle*, was utilized as a digital storytelling tool for children to explore, interact, and imagine in nature and to create, share and discuss their stories with others. Although storying is widely considered as an important literacy activity that has relevance for environmental education and place-based pedagogies [5], relatively little is known about the educational possibilities of augmented storying for children's interactions and relating with nature. The term "augmented reality" (AR) refers to technology that displays information, such as images, sound, and/or video on top of a view of the real world to create a sensation of immersion [7,8]. In this study, the story-telling application invited children to "capture" AR character named *Julle* by taking a photo of it in nature and creating a short narrative around the character. Afterwards, the digital stories of the children were shared, discussed, and elaborated on between children and adults in the classroom.

As there is a dearth of research knowledge on how AR technology acts in children's storying in nature, in our study we ask the question: How is the digital material interwoven into the children's storying in nature? and What literacies characterize the children's augmented storying in nature? Through our first research question, we inquire about the materiality of children's storying in nature with an aim to understand how the augmented storying tool, *MyAR Julle*, acts as a material force and invites children to interact and relate with nature. Our second research question focuses on the performativity of the children's augmented storying. We view children's augmented storying as "action texts" [9,10] that co-generate children's imagination, literacies, and momentary meanings. Here, we are interested in learning how nature, children, and the AR application *MyAR Julle* exist in relation to one another and the kind of literacies that are co-generated into being.

Next, we will explain how our study is embedded in a relational ontology and the scholarship of new literacies. We then provide more information about the empirical study situated in a city-run Finnish primary school and its curriculum. This is followed by a description of our data collection procedures in the children's classroom and in nature. We will also explain the visual narrative analysis [11–14], which we conducted on our data corpus comprising the children's narrative accounts with their augmented stories in nature, their augmented stories (i.e., digital artifacts), and video and observational data from the children's construction of their augmented stories in nature. Our article ends by considering what we can learn about the materiality and performativity of the children's augmented storying in, with, and for nature and what educational implications these learnings hold.

Relational Ontology and New Literacies: Conceptual Framing

Our study draws on a relational ontology and the scholarship of new literacies that advocate a non-representational approach to literacy [15]. That is, rather than understanding literacy as a representation of fixed meanings that are self-expressive, we understand children's augmented storying as performative that emerges through enacted relations and connections across signs, objects, bodies, and sociomaterial and cultural contexts in often unexpected and improvisational ways. We understand literacy as a socially and materially entangled practice that draws on a range of semiotic systems and multimodal resources [16].

Our approach holds that the texts that children use, produce, and move in their literacy activities are not "about" the world but are rather actions texts through which meanings emerge [9,10]. These action texts are also referred to in the literature as "maker literacies", directing attention to children's playful and creative tinkering with various materials and technologies, multimodal design and production, creative and critical thinking, problem-solving, communication, and collaboration [17–19]. From this perspective, the children's storying in nature can be viewed as being about imagining, thinking, communicating, and experiencing with the tools, contents, and contexts in situ and across space and time [20]. We also view children's literacy practices as fueled by affect, resulting in affective intensities that are different from the rational control of meanings and forms [21–23].

Our study differs from a more traditional understanding of materials as mediational means [24]. Instead, we treat matter and meaning as an entangled reality in which humans and materials intra-act

to influence the activity and its outcomes [25–27]. Hence, our approach emphasizes entanglement above separability. We also underscore the unpredictability of every action, which cannot be traced back to an individual or his or her pre-defined intentions [25]. On this basis, our study brings attention to the open-ended character of children's augmented storytelling in nature. We understand children's augmented storytelling as emergent and relational, comprising the complex relational dynamics of agency among children, teachers/adults, materials, and the natural world in situated, culturally framed activities. At the same time, we are interested in the agential cuts [26,28] in the children's literacy practices through which various phenomena materialize. For us, agential cuts demarcate the boundaries that make literacies distinct from one another. Thus, investigating agential cuts brings attention to enacted boundaries between and across literacies, which account for the children's augmented storytelling in nature.

2. Study

2.1. Participants and the Research Context

We conducted our study in a Finnish elementary school in the eastern part of Helsinki, Finland. The school is situated in a socioeconomically and culturally heterogeneous neighborhood surrounded by a rich natural landscape of woods, hills, and rocks. Altogether, 62 children, 38 boys and 24 girls, aged between 7–9 years old from four second-grade classrooms participated in the study. One of the classrooms serves children with special education needs. The children represent diverse language backgrounds (71% Finnish-speaking, 8% Arabic-speaking, 6% Russian-speaking, and 15% others, including children who spoke Albanian, Chinese, Portuguese, Burman, Estonian, Italian, Bosnian, and Nepali).

The children's augmented storytelling in nature was situated in a four-month long cross-curricular project that integrated environmental education, literacy education, and arts education. The educational design of the project also addressed the enhancement of children's multiliteracies and multimodal meaning making, critical thinking, and social interaction and expression in accordance with the Finnish curriculum [29]. The whole project was realized from October 2019 to January 2020 during a two-hour, once-a-week session as part of a regular school day for each of the four classrooms. The design of the cross-curricular project was realized in collaboration with the children's teachers and researchers. The data used in this study come from the beginning and end of the project, during which the children engaged in a story-telling activity with an AR application *MyAR Julle* (<http://www.myar.community/julle/index-en.htm>). The app is framed by a short orienting imaginative story about a forest elf, Julle, and it invites children to situate and create a story around the Julle character in nature.

In our study, the children's augmented storytelling in nature is framed by a pedagogy that aims to support children's being, interacting, and imagining with nature rather than merely learning about nature. Instead of presenting nature to children as an object to learn about, the emphasis is on children's wonder, imagination, and multimodal and embodied interactions with nature. This pedagogical approach is supported by research literature, which suggests that increasing knowledge about the natural world and its ecological problems does not alone connect children to nature or advance their valuing and caring for nature [5,30]. Instead, an emotional connection is needed [31]. Our pedagogical approach is also supported by research evidence, which suggests that children's framing of their interactions and relationship with nature is formed through multilayered and systemic relational dynamics that embody the mind, body, culture, and the environment and its materialities [32]. Nature is not an abstract or universal concept that solely develops in the children's minds; rather, it is a system of material and performative relations that include physical and material environments (e.g., plants, animals and fresh air, technologies), emotions (e.g., fun, peace, fear, anxiety), actions (e.g., play), and culture (e.g., freedom). Hence, children's holistic and embodied encounters with the natural world support their learning and framing of their relationships with nature [33].

2.2. Data collection Procedures

First, the children in each of the four classrooms were introduced to the *MyARJulle* application and its use with tablet computers. The introduction also included the children listening to a framing story about the AR character Julle, the forest elf. After the introduction, the children were grouped into pairs and each pair was given a tablet computer to “capture” Julle in nature and to create their personal stories. The teachers and researchers joined the children for the story crafting activities outdoors. The researchers video-recorded the children’s activities outdoors and made observational field notes. Figure 1 illustrates the children’s making of their Julle-stories in their school’s neighborhood.



Figure 1. Children creating Julle-related stories outdoors near their school.

Afterwards, the digital stories of the children were shared and discussed back in the school in semi-structured, conversation-type interviews. Each interview, which lasted between 10 to 20 min in total, was conducted by one researcher with a pair or a small group of three children. The open-ended interview questions focused on five themes: (1) Sharing the Julle story (e.g., What does Julle do in your picture/story? Why did you choose this place for Julle?) (2) Children’s experiences in nature (e.g., Do you often spend time in nature? What do you like to do there? Are there any specific sounds, scents, or other things in nature that you like or dislike?) (3) Children’s emotions towards nature (e.g., How do you feel when you go outside into nature? Do you like it? Is there something in nature that worries or scares you?) (4) Children’s perspectives towards nature and human–nature relationship (e.g., What does nature mean to you? Do people need nature? Does nature need people? Can humans help nature to be happy and healthy?) and (5) Identity (e.g., Do you think that you are a “nature child”?). The interviews were video-recorded and transcribed for analysis.

The data corpus of this study consists of 53 video-recorded and transcribed interviews during which the children narrated their Julle-related stories with the researchers, as well as video and observational data documenting the children using the application and constructing their stories in nature (1017 min of video data in total). This data corpus provides rich and complementary

information [34] for our analysis of the materiality and performativity of the children's augmented storying in nature.

2.3. Data Analysis

Our data analysis draws on visual narrative methods [11–14] and was realized as a recursive process characterized by back and forth reading, analyzing, and interpreting the data corpus. The first phase of our analysis involved sensitizing ourselves with the whole data, keeping an eye on our research questions. This was necessary so as to follow our commitment to the principles of relational ontology, which underscores treating data as an entangled reality in which the whole data corpus intra-acts together to create meaning. Further, we wanted to move beyond more typical representational modes of analyzing our data to studying the becoming of children's augmented storying in nature, that is, the materiality and performativity of the children's literacy activities.

In the second phase, we started to identify data sets in the data corpus in which we depicted how the augmented Julle character was entangled in the children's storying, i.e., in their narrative accounts of their storying, augmented story artifacts, and during the construction of their augmented stories in nature. Our aim was to investigate how the story-telling tool *MyAR Julle* acted as a material force and invited the children to relate with nature. Through repeated and active readings of the data corpus, we attempted to identify how Julle was positioned in the children's storying, and what roles and meanings Julle had in the children's storying in nature. This second analytic phase revealed data sets from the whole data corpus, which show how the children played with and through the AR character Julle; felt and sensed with and through Julle; re-storied their experiences, cultural knowledge, and identities with and through Julle; and engaged in critical thinking with and through Julle.

The third phase of our analysis was interpretative and was motivated by the goal to understand the kind of literacies, or action texts, in the identified data sets, which characterize how the augmented Julle character was entangled in the children's storying in nature. Here, we were interested to understand how nature, children, and the AR application *MyAr Julle* existed in relation to one another and the kind of literacies that were co-generated into being. We also aimed to understand the agential cuts in the children's augmented storying as to identify commonalities, differences, tensions, and interdependencies in the literacies we were identifying according to our research questions. The emergent literacies that we identified were compared, discussed, and elaborated against existing research scholarship on children's literacy practices.

Our analysis revealed how the children's actions of playing with Julle were performed through playful literacies. Affective and sensuous literacies emerged from the children's embodied actions and communication, which were connected with the children's feeling and sensing with Julle in nature. We also depicted identity literacies and cultural literacies in the children's augmented storying as they communicated their experiences and knowledge about the world and nature with and through Julle. Last but not least, we identified critical literacies as the character Julle functioned in the children's literacy practices as a critical and analytic observer and change agent for the well-being of nature. Next, we will illustrate and discuss our findings.

3. Results

The results of our study feature the material and performative nature of the children's augmented storying in nature, demonstrating how the augmented story-telling tool and its main character, Julle, was entangled in the children's literacy practices whilst interacting and relating with nature. We will introduce and discuss the results with empirical data examples illustrating how the children played with and through the AR character Julle; felt and sensed with and through Julle; re-storied their experiences, cultural knowledge, and identities with and through Julle; and engaged in critical thinking with and through Julle, along with the literacies that were enacted through these sociomaterial engagements. We understand our examples and their interpretation as entangled with the whole data and our findings that drip, stick up, and squeeze into our discussion of results.

3.1. Playing with and through Julle

Our results demonstrate the children's engagement in playful literacies in which the AR Julle character, nature, peers and the children themselves intra-acted in imaginative and creative ways. Many of the children imagined and played with the AR character positioning Julle in, on, or beside different plants and built constructions or abandoned objects, such as a bicycle. The Julle character was placed peeking behind the trees, sometimes hiding from adults or children or secretly observing them. Some of the children also pictured themselves, their peers, or the researchers in their stories, illustrating how they or other humans were interacting with Julle and nature in the story. The children also actively played with the technology, making the Julle character larger or smaller or turning the character upside down. This technological feature invited the children to experiment with proportions and composition. In one child's augmented story, a giant Julle is peeking out behind the school building, resulting in amusement among the children. The different versions of the Julle character that the children could choose from in the app similarly invited playful experimentation and the making of their stories.

In the illustrative example below, we can witness playful literacies as two children, named Simon and Mauno, explored different ways of positioning Julle in their stories. They were also experimenting with the size of the Julle character and where to place Julle in their visual story. The children's cultural interests and knowledge became part of their storying processes in a playful way. In Figure 2 (see a picture on the left), Mauno is doing a Dab dance movement originating from the hip hop culture and is currently popular on social media. This movement is encouraged by Simon who has suggested to Mauno: "Okay, go over there and do the Dab." Here, Mauno, Julle, and nature became part of Simon's storying. In his story (see Figure 2, picture on the right), Mauno explains how Julle might be falling from another planet to earth (Mauno: "It falls down straight to earth").



Figure 2. Simon and Mauno playing with Julle and nature.

In Isla's storying, Julle is hiding behind a tree and sitting on a rock (see Figure 3), demonstrating the children's playfulness with Julle in nature. She explains how, in her story, Julle is waiting for a friend. This is reflected in her written text: "He sits".

In the example below (see Figure 4), Isla is describing how she finds it fun that she can play with Julle by placing the character anywhere, even high up in the sky or on the rooftop of the school buildings.

In sum, the playful literacies that characterized the children's augmented storying in nature demonstrate experimental and imaginative literacy practices [35]. These playful literacies mobilized intra-actions between the children, materials, and nature resonating and rupturing the children's sensed reality and fantasy [36].



Figure 3. Isla playing with Julle and nature.



Isla: *I thought...that elf, for me it showed that it was there high up. [pointing at the sky and smiling]*

Researcher: *In the sky?*

Isla: *Yes, it shows [smiling]... and if you choose the "sitting elf", then you can place it over there [pointing at the school buildings rooftop and the sky] and then it can sit. Like over there, high up.*

Figure 4. Julle is high up in the sky.

3.2. Feeling and Sensing with and through Julle

Our results show that the children's augmented storying in nature was also rich in affect and senses [21–23]. The children seemed to enjoy creating augmented stories that, in various ways, reflected their earlier positive experiences in local nature. These stories were typically connected to specific places or things in nature, for instance, rocks or trees the children felt attached to. Some of the children emphasized the beauty of nature in their stories as they imagined the positive sensations these aroused in the Julle character and the children themselves. Meanwhile, the other children imagined Julle to feel uncomfortable or unhappy in nature. For example, in some of the children's augmented stories, Julle was depicted as feeling scared of falling from a high place or being afraid of humans and hiding from them. Seasonal changes were also entangled in the children's affective and sensuous literacies of their augmented storying. Some of the children depicted Julle exploring snow on the ground or watching and enjoying the snow. In some of the children's stories, Julle was feeling cold due to the snow.

Our next example characterizes Eeva's and Nellie's augmented storying in nature in which sensuous and aesthetic literacies emerged to the fore. When narrating her story (see Figure 5, picture on the left), Eeva describes how she wanted to situate Julle near to colorful bushes. In her narration, Eeva is also reflecting on the seasonal changes in nature, describing how the colors of leaves are in the process of changing and that she wanted to create a story that captures this seasonal change. Eeva also communicates how she thinks that life would be boring without nature. She reflects on the beauty she sensed in the seasonal change when creating her story.



Figure 5. Eeva and Nelli feeling and sensing with Julle and nature.

Similarly, Nellie's storying demonstrates how she felt and sensed with and through Julle in nature. In the following extract, Nellie (see Figure 5, picture on the right) is explaining how Julle is enjoying a nice view and calmness in nature. These feelings are further illustrated in Nellie's written text where Julle says: *"In the tree, yay!"*

Nellie: Well... It looks nice and there behind is like a nice view and so.

Researcher: Yes, it is wonderful, like woods. How do you think Julle would feel in that kind of place?

Nellie: Well, kind of nice and so that it would not be disturbed and it would be able to be alone.

Nellie's storying also extends from Julle to her personal sensing and feelings in nature. She explained in the interview how she personally enjoys the calmness in nature similar to the Julle character. In summary, Eeva's and Nellie's examples show how the human–material–spatial–temporal assemblage of the children's augmented storying in nature was fueled by affective and sensuous literacies, which emerge from their attentiveness to the details in nature and living through their feelings and senses with and through the AR character Julle.

3.3. Re-Storying Experiences and Cultural Knowledge with and through Julle

Our analysis of the data reveals how the children re-storied their experiences and cultural knowledge in nature, bringing forth their identities and cultural literacies in the process. These literacies communicated the children's experiences and understandings of local environments and places as well as people and other objects, both imagined and real. Through their augmented storying in nature, the children also defined themselves and others as well as established their momentary identities [37]. The enacted cultural and identity literacies established, stabilized, defined, and also redefined the children's identities and cultural knowledge in relation to nature, thus opening opportunities for personal and collective dialogue and reflection [20].

Our example below (Figure 6) illustrates the storying activities of Liam and Theo. It illustrates the children's collective planning, designing, and making of Theo's story in nature. It shows how the children's cultural knowledge about camping materialized into their storying in nature.

The cultural and identity literacies were also vividly present in the children's narrations of their stories back in the classroom. In the interview, Theo explains how in his story Julle sits by the fireplace and toasts marshmallows (Theo: *"It wanted to go camping and it enjoys it"*). His augmented story includes an explanatory written text that says: *"Julle is at the camp"* (see Figure 7, picture on the left). Theo's storying is also entangled with his experiences and knowledge about camping as Theo explains how he and his grandpa plan to make trips to the forest next summer and to set up camp with a fireplace. He explains that this is something he is very much looking forward to doing.



Theo: *Let's do a campsite for it [smiling], could you [Liam] perhaps make a fireplace?*

Liam: *Yes, I will make a stick for it where it could sit. [starts looking for and picking branches from the ground] Then I will pretend to make a fire. [picking up one very small branch and starts to bend it to make firewood to the scene]*

Theo: *It is a bit small. [referring to the stick in the picture]*

Liam: *Well, you can come a little bit closer. [referring to the researcher's earlier advice on how to get a picture of Julle sitting on a small rock]*

Theo: *[Sits down to adjust and see how it works to take a picture of Julle next to the built fireplace] Yes, now it is.*

Liam: *[Walks next to T to observe the picture]*



Theo: *Then a fireplace.*

Liam: *I will make the fire, pretending to, not like a real fire.*

Theo: *Yes.*

Liam: *[Breaking small sticks and placing them carefully on the ground, using them to build a small fireplace]*

Theo: *[Looking at the tablet]*

Figure 6. Theo and Liam re-storying their experiences and knowledge with Julle and nature.



Figure 7. Theo and Liam re-storying their experiences and cultural knowledge with Julle and nature.

In his storying, Liam (see Figure 7, picture on the right) is viewing the world and nature through the eyes of Julle. He describes how Julle is hiding in the branches from people, elaborating on his written text “Julle is sitting on a branch.” Liam also explains in detail how this is a good place for Julle as people do not usually notice or look closer at smaller branches, something that Julle is aware of.

In sum, our results showed how augmented storying in nature invited the children to engage in personal and cultural literacies, which were relevant and meaningful to their own daily lives. Augmented storying with Julle appeared to act as an encounter through which the children could find and re-define themselves, their knowledge, and experiences as well as other people and nature.

3.4. Critical Thinking with and through Julle

Our analysis brought forward critical literacies in the children's augmented storying in nature. These literacies became visible to us whilst the children addressed their observations and concerns about human-centric values and behaviors towards nature. The critical literacies the children engaged with indicated how their augmented storying moved beyond the creation of digital story artefacts to cultural production, which held emancipatory and transformational potential [38,39]. Here, we started to depict literacies and literacy practices, which were not only situated *in* and *with* nature but also *for* nature.

At times, the critical literacies of the children's augmented storying functioned as opinion statements that at least implicitly called for attention and wider audiences. This is also the case in our example where Sebastian explains his storying about human–nature relationships through the Julle character. Sebastian describes how he has created two contrastive stories around Julle. In the other story, Julle is called “*Human Julle*”—a character who does not spend much time in nature. In this story, Julle is peeking behind one of the corners of the school building. Sebastian explains that this signals that the story is connected to humans. In the other story, Sebastian is describing “*Nature Julle*” who enjoys nature and likes to be close to trees. When narrating his story, Sebastian is also imitating Julle's voice and using his own fingers to gesture and demonstrate how Julle is talking. The extract below (see Figure 8) illustrates how through his storying Sebastian is considering human's relationship with nature.

Later in his interview, Sebastian considered how humans are destroying nature by littering, suggesting that nature would be better off without humans (“*No, but it (human littering) destroys earth ... because we have littered it so much*”).

Our other example that illuminates the children's critical literacies stems from Silja (see Figure 9). In her story, Julle is a guard that protects nature. Silja explains how Julle is watching out for humans and their behavior in nature. As she has written in her story: “*Julle is sitting in the jungle gym*”.



- Researcher:** *So, why did Julle come and observe humans?*
Sebastian: *[Talking and gesturing using his fingers] Because it is watching that they are not doing anything bad and Santa Claus will give them presents! [laughing]*
Researcher: *So it is Santa Claus's elf?*
Sebastian: *Yes.*
Researcher: *Quite good...*
Sebastian: *Because it looks like.*
Researcher: *What does Julle think of nature? Is it often in nature?*
Sebastian: *No, it is there!*
Researcher: *Is it more among humans?*
Sebastian: *Yes.*

Figure 8. *Cont.*



- Sebastian:** [Changes picture] This one likes nature!
Researcher: What?
Sebastian: This one likes nature!
Researcher: Of course, there is another one that likes nature. Could you show the other picture to the camera...That one, nature Julle.
Sebastian: [Imitating Julles voice and gesturing with his fingers] My name is Nature Julle.
Researcher: Human-Julle and Nature-Julle.
Sebastian: Yes. [then changes picture]

Figure 8. Sebastian’s critical thinking with Julle.



Julle istuu kiipeilytelineessä

- Silja:** This is mine.
Researcher: So that is yours, let’s see.
Silja: [Shows picture to the camera] I took a picture like this of Julle. It is like sitting in the jungle gym and observing, like the countryside and these kinds of places and if they are clean. And then it is thinking if it should gather like trash.
Researcher: Okay, how do you think that Julle is feeling in that picture?
Silja: It is feeling scared, because it can’t get down
Researcher: Okay and...
Silja: It was going to jump, but then it realized that it is too high up.
Researcher: And why is Julle on that particular spot?
Silja: Because it went there to observe if there is trash anywhere
Researcher: Okay, so it is a trash observing Julle.

Figure 9. Silja’s critical thinking with and through Julle.

In her narration, Silja describes how Julle watches out for people throwing trash. During the construction of her story in nature, Silja also shares how she and her friend are together picking up trash to protect nature, implying that her storying in nature is interwoven into her values and collective pro-environmental acts. Here, the “ethics of being” with and for nature arose from Silja’s literacy practice [40], thus opening a space for relational agency towards sustainable action.

4. Discussion

In this study, we draw on a relational ontology and scholarship of new literacies by investigating the materiality and performativity of children’s augmented storying in nature. Specifically, we sought to understand how the augmented storying tool, *MyAR Julle*, intra-acted as a material force in the children’s interaction and relating with nature, co-igniting children’s imagination, literacies and momentary meanings. Through our investigation, we were interested in generating new knowledge about how children, nature, and the AR character Julle co-existed in relation to one another and the kind of literacies that were performed into being.

The rationale of our study is embedded in global educational efforts that address the need to rethink ways in which children are provided opportunities to interact and relate with nature [5,30,41]. This includes supporting children’s connectedness to nature and seeing themselves as part of the living systems of the Earth. Our study reveals how these goals were addressed through children’s augmented

storying in nature. By doing so, the study provides education professionals and researchers with insights into the educational possibilities of utilizing novel pedagogies and technologies to promote children's interaction and relation with nature.

In our study, the children's augmented storying in nature was framed by a pedagogy, which aimed to support the children's being, interacting, and imagining with nature in holistic and emotionally connected ways. Instead of presenting nature to children as an object to learn about, the emphasis was on the children's wonder, imagination, and multimodal and embodied interactions with nature. The pedagogical approach was framed by the Finnish national curriculum, which encouraged cross-curricular projects based on children's interests, curiosity, play, and imagination as well as multimodal communication and meaning-making through various technologies—old and new [29].

At the same time, we understand that for many environmental educators and scholars, digital technologies are regarded as the main cause for many children's disconnect to nature while also hindering children's interactions and engagement with nature [42,43]. There is also considerable public anxiety about excessive screen time for children [44] and the effects this has on their physical, emotional, and mental health [45,46]. However, how can novel technologies be harnessed in education in ethically responsible ways that recognize children's rights, and the opportunities and threats of novel technologies for their literacy practices and learning warrant more attention. Moreover, how children actually use novel digital technologies to engage actively with nature in pedagogically framed activities has not been adequately theorized nor empirically studied. Our study responds to these theoretical and empirical gaps.

The results of our study reveal how the children's augmented storying in nature was performed through playful, affective, and sensuous identity, cultural and critical literacies, which were imaginatively constructed into being at the nexus of the children's sensed reality and fantasy. The identified literacies of the children's augmented storying in nature make visible human-material-spatial-temporal assemblages during which the children played with and through the augmented character Julle, felt and sensed with and through Julle, and re-storied their experiences, cultural knowledge and identities with and through Julle. They also engaged in critical thinking with and through Julle. These literacy activities enabled the children to enact living and imaginative inquiries into themselves and other human beings, materials, technology, and nature. The AR character Julle acted as an agent in the children's interactions and relating with nature, an agent that elicited actions, movement, and further relations. Hence, Julle effectively became part of an improvisational dance at the nexus of the children and nature.

Augmented storying in nature invited the children to immerse with the Julle character and with their own experiences, knowledge and values, and with nature in ways that many of the key notions of (eco)literacies were enacted into being [47,48]. Mainly, augmented storying in nature invited the children to explore nature and its various elements—immaterial and material—from a range of perspectives and positions. Here, nature became alive and entangled with the children's embodied literacies as they explored, inquired, and imagined "*what was out there*". The children's immersive investigation also awakened their awareness of nature, themselves, and other humans. In their storying, the children also paid attention to the environmental details, such as space, seasonal changes, temperature, and aesthetic details.

The children's sharing of their experiences and cultural knowledge brought forward their identity and cultural literacies through which they defined and redefined themselves and others, and established their momentary identities [38]. The children's living inquiry, playfulness, and imagination did not only retell a story and document sensed reality but invited the children to engage in imagining the "*What if*" (i.e., imaginative interpretation), thus allowing them to "*disclose possibilities—personal, social as well as aesthetic*" [48]. While playing with the Julle character and augmented technology, the children drew upon their imagination, experiences, and knowledge in relation to nature and created alternative realities and futures, also considering "*What then*" and "*What can we do?*". These literacy practices evidence the children's critical thinking, participation, and sustainable action.

Our findings provide important insights into the meaning of materiality in children's storytelling in, with, and for nature as well as the educational possibilities of augmented storytelling for children's (eco)literacies. Our study shows how augmented storytelling resulted in the creative explorations of meanings regarding what nature can mean to children and how they position themselves in relation to nature. Augmented storytelling encouraged the children's sensory, experiential, perceptual, relational, cultural, and critical investigations of nature, thus creating a space in which children can express and create their voice in relation to nature. Here, the children's personal literacies became entangled with broader social and ecological literacies.

We understand that our study is only a beginning for gaining a deeper understanding of the educational possibilities of children's augmented storytelling in nature; hence, more studies are needed in the area. For example, we need knowledge on how children's augmented storytelling activities can be linked with different educational programs and their pedagogical approaches addressing children's literacy, arts, and environmental learning opportunities in unison. In these investigations, attention could be paid on how augmented storytelling interacts with children's interests, understanding, and innate values in relation to nature, humans, and technology. Also, how digital storytelling with AR technologies can be incorporated into education programs with limited resources and which do not rest on creative pedagogies requires more research attention. In addition to investigating different pedagogical arrangements and programs, we need more knowledge about how contextual issues, such as children's cultural background and material and geographical conditions, intra-act with the children's literacy practices and learning opportunities during their augmented storytelling in nature. We also need further knowledge about the role of adults in supporting and joining children in collective imagination and knowledge building towards a socially and ecologically just future.

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