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Bosch, Noora

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Design Empathy in Students' Participatory Design Processes

Noora Bosch, University of Helsinki, Finland
Tellervo Härkki, University of Helsinki, Finland
Pirita Seitamaa-Hakkarainen, University of Helsinki, Finland

Abstract
In this exploratory case study, we focus on empathy, an important aspect of contemporary design practices. We aim to explore how design empathy manifested in students' design processes. A three-month participatory design project was created and assigned to students (aged 14–15), with the following brief: 'co-design and make an e-textile product for kindergarteners according to their wishes and needs'. We examined 72 end-user-related design episodes from two student teams (six students in total), analysing students' end-user-related considerations, as well as different signs and dimensions of empathy. Our findings indicate that the students considered, discussed and referred to topics concerning end users during the process. Signs and dimensions of empathy were found in the various end-user-related discussions and empathetic considerations, through which end-user-friendly design products materialised. We conclude that students could practise empathic design by acknowledging end users in multiple concrete and abstract ways and designing and manufacturing meaningful products for end users. This offers new opportunities for engaging students in reflective (digital) design and making, targeting design-literate citizens in the 21st century. However, this novel field requires further studies in educational contexts other than higher education, which currently has the best research coverage.

Keywords
Empathy, design thinking, participatory design, maker education, STEAM, 21st-century skills

Introduction
Over the past few decades, the focus of design has been shifting to more participatory, collaborative and context-driven (i.e., human-centred) approaches (Kouprie & Sleeswijk Visser, 2009; Sanders & Stappers, 2008). Empathy is one of the core attributes of designers in the future design, as it enables connecting with people and communities, and through this, design and generate meaningful design solutions (artefacts, services and experiences) (Tellez & Gonzalez-Tobon, 2019). Dindler and colleagues (2020) argue that participatory design (PD) has a lot to offer in engaging and empowering students in the process of designing, making, and learning with and about new technology and how it affects the world around them (see also DiSalvo & DiSalvo, 2014; Iivari, 2020). In PD, the design is a social and collaborative process among diverse stakeholders, and ideas must be explored in a hands-on way and tried out early in the design process, emphasising human centredness and empathy (Björgvinsson et al., 2012).

Research with a focus on empathic or human-centred design at primary and secondary education levels is still limited (Klapwijk & Van Doorn, 2015). Earlier studies with such a focus (notably in the Netherlands and England) mainly concentrate on developing and analysing

methods to facilitate empathic and human-centred design (see e.g., Demetriou & Nicholl, 2021; Klapwijk & Van Doorn, 2015; Van Mechelen et al., 2018). In the US, Goldman and Kabayadondo (2016) and Noel and Lu Liu (2017) have promoted empathy building through the methods of design thinking, and Clapp et al. (2016) have discussed its relation to community-based maker education.

Empathy in design involves interrelated cognitive processes and affective experiences (Kouprie & Sleeswijk Visser, 2009). We define empathy based on Cotton's (2001, pp. 10) review: '(1) the affective capacity to share in another's feelings, (2) the cognitive ability to understand another's feelings and perspective, and (3) the ability to communicate one's empathic feelings and understandings to another by verbal and/or non-verbal means'. As empathy and empathic formation can be developed (Cotton, 2001; Singer & Lamm, 2009), we explored the possibilities of using and fostering empathy in a PD school project in a Finnish lower secondary school. Relying on the notion that end-user-related discussion can indicate empathy (Van Rijn et al., 2011), we aimed to gain an increased understanding of how design empathy (thereafter, empathy) was manifested in the students' verbal design episodes. In this study, we asked the following research questions: 1. What kinds of design aspects did the students consider during their end-user-related design episodes, and how were they driven by their empathy for the end users? 2. How did design empathy manifest in the students' end-user-related design episodes?

Empathy in Design

Empathic design was originally aimed for designers to understand and make sense of the human experience in order to develop successful products (Koskinen et al., 2003; Leonard & Rayport, 1997). However, over the past few decades, end users have been more actively involved in building possible alternative futures through co-design and PD methods (Tellez & Gonzalez-Tobon, 2019). Although empathy is an essential part of contemporary design, the field lacks a fundamental understanding of what empathy in design is and how it can be achieved (Kouprie & Sleeswijk Visser, 2009).

As noted by Smeenk and colleagues (2019), in the social-psychological literature, empathy is usually divided into cognitive processes and affective experiences and the ability to be attuned to or distinguish between the self and others. Kouprie and Sleeswijk Visser (2009) created the framework for empathy in design, which integrates these factors, and they emphasised the need for a balance between users' ideas and visions, alongside designers' personal insights and experiences. Van Rijn and colleagues (2011) emphasised motivation and willingness as important factors in empathic design. Later, Smeenk and colleagues (2016) stated that acknowledging different perspectives would be valuable in empathic design. Hess and Fila (2016) integrated four dimensions – cognitive processes, affective experiences, self-oriented and other-oriented – into their conceptualisation of empathy. Those dimensions, as well as the empathy factors proposed by Baldner and McGinley (2014), functioned as the basis for Smeenk and colleagues' (2019) framework for evaluating a junior designer's empathic capacity. Smeenk and colleagues' (2019) framework comprises five dimensions that indicate empathy: the other-oriented categories of emotional interest (EI, i.e., cognitively attending and attuning to users' emotions) and sensitivity (SE, i.e., affectively attuning to and being in contact with others), the self-oriented categories of self-awareness (SA, i.e., distinguishing between the representations of one's own actions, perceptions, sensations and emotions, on one hand, and those of users, on the other hand) and personal experience (PE, i.e., connecting to and reflecting on one's own

relevant experiences), and the 'mixed perspectives' (MP), which indicate that designers can alternate between other-oriented and self-oriented perspectives. Based on these studies, empathic design appears as a dynamic and relational process.

Methods

Participants and Research Settings

This qualitative case study was organised in a public lower secondary school in Helsinki as part of an elective eighth-grade craft course. The project is part of larger efforts (Growing Mind project funded by the Academy of Finland) to bring design and maker education to Finnish primary and lower secondary schools and develop the Finnish Invention Pedagogy in close research–practice partnership with schools. Ten participants (aged 14–15), who had prior experience in textile crafts but none in PD, co-design methods, e-textiles or collaboration with kindergarteners, were divided into three teams (2 teams with 3 members each, and the third with 4 members). Craft teacher, researcher, two kindergarten teachers and 16 kindergarteners (aged 6–7) also participated in the project. The overall idea for the project was formed in collaboration with the kindergarten teachers. Kindergarten is obligatory in Finland, so all students had experiences of kindergarten daily activities and routines. Thus, it was considered easier for the students to be attuned to the end users' needs by knowing the design context at some level.

The first author (thereafter, researcher), who is also a craft teacher and designer, designed the project's overall structure and planned the design brief and the design tasks. The plans were discussed and revised weekly with the responsible craft teacher, and both facilitated the students' design process collaboratively. The teacher and the researcher already knew each other, so their interaction and collaboration proceeded smoothly, which was conducive to creating the proper classroom atmosphere for creativity, sharing experiences and risk-taking. The students were supported in finding their own paths to contribute to the design process. Since the project was part of formal education, the teacher was responsible for the students, for teaching them and for the assessment, giving her a certain power position. Familiarity with the school allowed the researcher to plan and be present in all sessions with the teacher, which helped obtain the holistic picture of the process.

The design brief for the project was to 'co-design and make an e-textile product for the kindergarteners according to their wishes and needs'. The task emphasised collaboration among the team members; considering other people's ideas, feelings and needs; and thinking creatively about how technology could be used in the designed products. Moreover, the students had to physically leave the school building, visit the kindergarten and take the role of a 'participatory designer' in front of the pre-schoolers. Both the teachers and the kindergarteners were considered the end users. The three-month project was undertaken in the spring of 2019. The class met 12 times in weekly 90-minute sessions; the last three sessions were dedicated to student presentations and the post-questionnaire (Table 1). The teams documented their process in the digital SeeSaw portfolio. For this project, the teacher wanted to mix the groups to prevent some generally unmotivated students from being in the same group.

Table 1. The design process phases and activities (*not fully recorded; **not recorded).

Sessions	Design process phases	Activities
1*	Discover & empathise	Writing memories and reflections on post-it notes; drawing empathy maps; filling up the pre-questionnaire
2*	Discover & define	Visiting the kindergarten; observing the space; directly interacting with end users; collecting data on their needs and wishes
3	Define & develop	Forming small groups (ice breaker); asking 'How might we…' questions; ideating in small groups; voting
4	Develop & deliver	Ideating in small groups, making fast mock-ups; end users visiting the students' classroom to watch their presentation and provide feedback; collecting feedback
5	Develop & deliver	Developing and finalising the concepts according to the end-user feedback
6	Manufacture	Manufacturing the products
7*	Manufacture	Open day: parents visiting; manufacturing the products
8	Manufacture	Manufacturing the products
9	Manufacture	Finalising the project and the poster
10*	Deliver & present	Delivering the outcomes; making presentations in front of the end users
11**	Share	Sharing to a wider audience at the University of Helsinki Invention Fair
12**	Reflect	Filling up the post-questionnaire; reflecting on the overall process

The project followed the Double Diamond design model (British Design Council, 2005) and started with empathising. This model was chosen because of its focus on empathy. In Session 1, the students made empathy maps; in Session 2, they visited the kindergarten for need observations and interacted with the end users. Based on those observations, the end users' needs and wishes, and discussions with them, the researcher put together different 'How might we...' questions for Session 3. The students brainstormed solutions to the design challenges and subsequently voted for their favourite concept to work with. Then, concepts were developed, and rapidly constructed mock-ups were presented to the end users in Session 4. These concept designs were developed further, based on the end-user feedback, and the manufacturing phase started in Session 5. Finally, in Session 10, the functional needs-based design products – 'Season Tree' and 'Strength Crow' (Figure 1) – were brought to the enthusiastic kindergarteners. Later, the students and the craft teacher presented the project (Session 11) at the city-centre Invention Fair, organised by the research team from the University of Helsinki.

Figure 1. Season Tree and Strength Crow products designed and manufactured by the students.

Data Collection and Method of Data Analysis

In this study, we focused on analysing the design (including manufacturing) processes of two student teams, according to the students' willingness to participate in the study. Team 1 (Emmi, Sofia and Sara – pseudonyms) designed the Season Tree. Team 2 (Iina, Senja and Rosa) designed a soft toy called the Strength Crow. Research permissions were obtained from all participating students, and versatile data were collected during the project.

The primary data comprised approximately 18 hours of video recordings from classroom Sessions 1 to 9. Go-Pro video cameras were placed on each team's table and were moved around the class when needed. Some sessions were not fully recorded; in Session 1, filling up the pre-questionnaire was left out, and we did not have the research permissions for video recording in the kindergarten visits (in Sessions 2 and 10) and from all parents during the open day (Session 7). Session 11 at the UH fair and Session 12 were not recorded, as the former was a public event for hundreds of people, and in the latter, the students filled up the post-questionnaire and reflected on the process individually. Additionally, we had some technical problems capturing Team 1 members' voices as they actively moved around the classroom (Sessions 6 and 8). Altogether, the video data analysed in this study comprised approximately 10 hours of video recordings.

The secondary data comprised photos of the students' sketches, mock-ups, ideation notes and final design products; the researcher's field notes, research diary and voice memos made after the lessons; the students' pre- and post-questionnaires, and other pedagogical materials, such

as PowerPoint slides for the class. These secondary data were utilised to support monitoring the overall process and to confirm our results.

The qualitative data were analysed in several cycles and at several levels, adapting the model proposed by Derry et al. (2010). The first phase comprised writing a rough content log of all video data to obtain an overall picture and reveal the main contents and various activities of the sessions in the design process. Then, we systematically identified all those episodes in which the student teams held discussions related to end users (e.g., the user environment or possible future use of the design). We utilised MAXQDA software for the qualitative data analysis and the identified 72 end-user-related episodes that were transcribed verbatim. Analysing the students' team discussions relating to end users enabled us to reveal the kinds of empathic concerns, experiences and reflections that emerged from the students' interactions in the design process. Based on the 72 end-user-related episode transcripts, we created a process table similar to Ash's (2005) flow chart. To this end, we added versatile basic information (e.g., session, project phase, data collected and assignments) and photos of the students' post-it notes, sketches, mock-ups, notes and design products to better monitor the overall process.

The overall analytical process was accompanied by the writing of memos, which included definitions of categories, preliminary analytical notes and questions raised from the analysis. Whenever the transcripts failed to fully capture a specific moment, we returned to the video data to strengthen our analysis.

To answer the first research question – What kinds of design aspects did the students consider during their end-user-related design episodes, and how were they driven by their empathy for the end users? – we utilised the data and theory-driven analysis (Hsieh & Shannon, 2005) to identify the main design aspects related to different kinds of end-user-related design episodes. In this analysis, we focused on the product-centric and the people-oriented aspects (Table 2). The product-centric aspects comprised discussions about functional features or solutions (how a product functions or what its purpose is, e.g., what it teaches children), technical solutions (how the product can be produced, e.g., which material is suitable or how a certain digital technology functions) and visual and aesthetic features (what the product will look like, e.g., its attractiveness and shape).

Human-oriented aspects comprised self-oriented and other-oriented aspects (based on the model of Hess & Fila, 2016) of end-user-related design episodes. The students' self-oriented experiences and knowledge included their own experiences from kindergarten, experiences of the topic at hand or the kindergarten visit (e.g., previous experiences in craftmaking or what was seen in kindergarten). The other-oriented considerations were derived from the end users or their needs, wishes and feedback (e.g., kindergarteners learning about seasons or end users' preferred colours).

Table 2. Categories and examples of design aspects in end-user-related discussions.

	Categories of design aspects	**Examples of design aspects in end-user-related discussions**
Product-centric	Functional	*'...those snowflakes could be used at least in the beginning of spring...'*
	Technical	*'...somehow (made) of such type of plywood sheet, and then, it will be attached to the wall...'*
	Visual/Aesthetic	*'...it would look more vivid...'*
Human-oriented	Self-oriented	*'My guess is that if those weren't safe, then we wouldn't do this sort of thing, so…'*
	Other-oriented	*'Yep, so that they can read it.'*

To answer the second question – How did design empathy manifest in the students' end-user-related design episodes? – we applied Smeenk and colleagues' (2019) framework. However, we extended its descriptions of categories based on earlier studies (Van Rijn et al., 2011; Smeenk et al., 2016; Hess & Fila, 2016) to better support our analysis (see Figure 2). Hess and Fila's (2016) model lacked designers' own contextual experiences; furthermore, compared with Kouprie and Sleeswijk Visser's (2009) framework, we found that Smeenk and colleagues' framework offered a more detailed analytical lens for our needs, which was easier to operationalise to our data.

Our extended framework comprised four empathy dimensions from Smeenk and colleagues' (2019) framework: PE, SE, EI and SA. During the analysis, we searched for the following signs of empathy (similar to those used by Van Rijn et al., 2011): voiced empathic expression (e.g., 'I think/feel/guess the kindergarteners feel/think/want...'), expressions comparing or relating to one's experience (e.g., 'I remember when I was...'), questioning user needs or making assumptions about user needs, and announcing certain facts or knowledge related to the users (e.g., 'Some kindergarteners can read already.'). All these discussions and expressions were coded with the four dimensions, but these dimensions were not exclusive. As our whole study was organised to emphasise Smeenk and colleagues' (2019) MPs, the latter as considered more of a design strategy rather than its own category during the analysis.

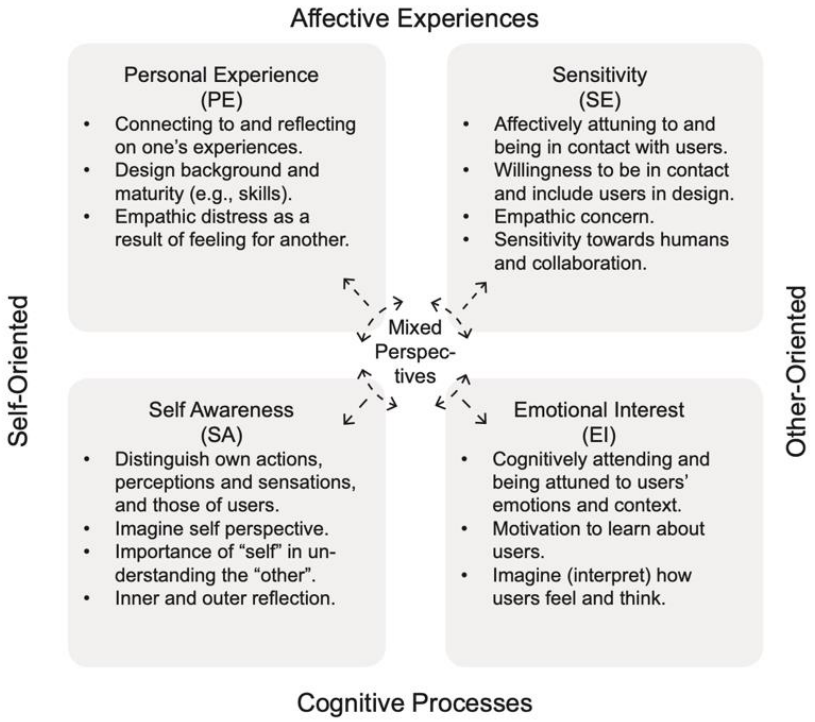

Figure 2. Design empathy framework, extended from the framework of Smeenk et al. (2019).

Findings

In general, both student teams were very active and engaged in the given design project that was quite different from the usual craft studies. We identified a total of 72 end-user-related design episodes with various durations. Team 2 discussed about and referred to the end users, not only in the beginning of the project but throughout the project. From Team 1, we could not verify end-user-related discussions on the manufacturing phase (Sessions 6 and 8), as the students actively moved around the classroom and mostly focused on their individual work. In this section, we start by answering the first research question related to the concrete user-centred design aspect that they considered during the project. Then, we explain our analysis of the more abstract-level empathic dimension.

'What kinds of design aspects did the students consider during their end-user-related design episodes, and how were they driven by their empathy for the end users?

Our analysis revealed that the students considered various product-centric and human-oriented design aspects in 72 end-user-related design episodes. In both teams' processes, the most common end-user-related design episode featured functional and other-oriented aspects. The findings also indicated that other-oriented end-user-related considerations and the students' self-oriented experiences played a role during the design process. Notably, these five design-aspect categories were not exclusive, and most of the time, the students' discussions related to many categories within the same episode.

The functional category included various considerations of the product's purpose or the kinds of intended functions it might perform and how these features could be included in the final design. For example, Team 2 (Strength Crow) pondered whether the crow could play a sound

when the noise in the class was too loud, thereby functioning as a noise warning system, or whether the crow's eyes would be blinking LED lights.

> *Rosa: 'And what if the [LED] lights would be the eyes [of the crow]? Or some buttons here?'*
> *Senja: 'Yeah, I was also just thinking that the LEDs could be used there. But I don't know how about the sound; is it [the crow] going to caw somehow?'*
> (Team 2, Session 4, Episode 1)

Team 1 (Season Tree) discussed how children could decorate the tree by themselves and how snowflakes could represent the wintertime and green leaves could symbolise the summertime.

> *Sara: 'Yeah, in principle then, the summer, autumn and spring leaves could be mixed up all over the place. And those snowflakes could be used in the beginning of the spring at least.'*
> (Team 1, Session 5, Episode 6)

The technical considerations related mostly to material choices, for example, whether Velcro should be used to attach the strength cards to the Strength Crow or whether real (wet) branches should be used on the Season Tree. Deliberations about the water resistance of the programmable board, the strength of the material or coding issues were also included in the technical considerations.

> *Senja: 'We had this idea, that, well, last time, [it] came up that they wanted that noise meter, so it would be that circle [programmable board] in its stomach. But now, I [have] started to think where we [should] connect those strength cards then.'*
> *Iina: 'Yeah, but what if they are connected with some Velcro?'*
> *Senja: 'Yeah, if we put it, if there was a Velcro in those wings.'*
> (Team 2, Session 6, Episode 1)

The following excerpt represents the discussion about using LED lights in the Season Tree:

> *Sofia: 'If there was a light inside those leaves, or there in the middle of the flowers...'*
> *Emmi: 'Yeah, I thought also that in the middle of the flowers. But if those flowers are removable, how do you get it [the light] connected to the circuit?'*
> *Sofia: 'What?'*
> *Emmi: 'Well, look, if those flowers are removable, how do you get it [the light] connected to that circuit if you remove them in the middle? Yes, that press fastener, if we get that…'*
> *Sofia: 'That press fastener, and then it [the light] goes on.'*
> (Team 1, Session 5, Episode 9)

The visual and the aesthetic aspects were also actively considered by both teams. These issues included several considerations about the size and the model of the product. For example, Team 1 pondered whether the sketch of the Season Tree looked too scary for the children and how to make the tree visually more attractive with bright colours. The idea was that the different seasons were represented by using different leaves or flowers; thus, the tree's

colours, font model and material and leaves were considered important aesthetic features to ensure that the kids would like it.

> *Sara: 'I thought that in autumn, it rains a lot, so I put a rain drop, and then, I don't know if it looks like a maple leaf. But perhaps with these colours, so that they all understand what is being sought by this. I thought that this flower could be some, or these could be yellow and red and some of those really bright colours that come out or so...'*
> (Team 1, Session 5, Episode 12)

Team 2 considered whether capital fonts were easier to read or whether rainbow colours would be well liked. Furthermore, the colour of the LED lights was intended to change according to the different strengths, but LED lights in the eyes of the crow were considered too scary.

> *Iina: 'Those types of that, they will see them.'*
> *Senja: 'And that it looks nice for them.'*
> *Iina: 'Here, we got rainbow colours.'*
> *Rosa: 'Yeah.'*
> *Senja: 'Everyone can be pleased.'*
> (Team 2, Session 8, Episode 1)

The human-oriented aspects were interwoven with product-oriented aspects. The self-oriented category comprised notions where the students brought up or recalled their prior experiences in kindergarten, the kindergarten visit or craftmaking. For example, Team 2 discussed what they had played on the kindergarten field trips. They also referred to the experiences collected during the kindergarten visit.

> *Emmi: 'We did have, we had some kind of rabbit with Arthur [their previous teacher], didn't we?'*
> *Sara: 'No, we didn't, but that was no strength [-based creature].'*
> *Emmi: 'Yep, they didn't have any such features.'*
> *Sara: 'They [kindergarteners] have that bunny, some kind of brown hare, in kindergarten.'*
> (Team 1, Session 3, Episode 4)

They used personal emotions as part of the design as well. Earlier experiences in craftmaking were also in this category, as if they were connected to making for the end users.

> *Sofia: 'Well, I feel that many would get bored with that sound, but…'*
> *Emmi: 'I would lose my nerve.'*
> (Team 1, Session 3, Episode 16)

Nevertheless, we also detected one PE/personal emotion that might have negatively affected the empathic process, as Rosa from Team 2 stated in Session 6, 'I don't want any dark colours; I hate dark colours.'

The other-oriented category comprised notions derived from or concerning the end users or their situations, needs, wishes or feedback. This category represented the clearest end-user-

centric considerations during the design process, for example, statements recalling what the end users had expressed earlier. These needs and wishes were especially discussed during the ideation phase, in which the students generated different solutions, such as proposing a 'dressing-up game' to motivate the children to dress up in winter overalls faster before going outdoors, as it is a daily practice in Finnish kindergartens. They also suggested educational ideas about the water-level metre to indicate with a light when the plants in the classroom need more water in order help the children take care of the plants. Later, the student teams considered what kind of feedback they could request from the end users or how the teams could include user wishes in the design of the artefact, as the following examples indicate:

> *Emmi: 'Well, they wanted some branches there, and we thought that it would be quite difficult, so we thought [that] if we would roll up some fabric and then attach them longitudinally to that.'*
> (Team 1, Session 5, Episode 11)

> *Senja: 'It is ok, when it can be placed in the stomach like that. They [kindergarteners] told [us] that it would be nice to have the buttons there.'*
> (Team 2, Session 5, Episode 5)

> *Senja: 'Rosa, what we... what could those questions [for the end users] be? If the other would be that would they [the kindergarteners] want that it [the crow] would have that kind of colourful eyes that would light up? Then, what could the other question be?'*
> *Rosa: 'Don't know.'*
> *Senja: 'Well, could it be, for example, that where are they [the end users] going to store it, is it somehow attached to that tree, or is it on the table, so do we have to make some... [fastening part]... or something like that?'*
> (Team 2, Session 4, Episode 10)

Both teams' solutions were developed to offer tangible products to support kindergarteners' learning. The main function of the Season Tree was to demonstrate different seasons in a more realistic and motivating way, as the children could change the leaves, flowers and snowflakes by themselves. The Strength Crow was developed for playing and supporting strength-based education and measuring the noise level. During their kindergarten visit, Team 2 noticed that the space was small and noisy, which triggered the idea of utilising the programmable e-textile board for this purpose.

Many design aspects (e.g., safety, appearance and usability) discussed by the students were driven by their empathy for the end users, as illustrated above. For example, Velcro was chosen to be used for both products, as it enables kindergarteners to change the strength cards, leaves and snowflakes easily and safely, supporting more autonomous, tangible and versatile learning opportunities. The use of the products was considered in terms of easy maintenance and sturdy materials so that they would not break in the children's hands. The visibility of the fonts and LED lights, as well as the pleasant sound of the crow, required the students' perspective taking. Furthermore, different features of and solutions for the final products were derived from the end users or their stated needs, wishes and feedback (other-oriented) or from the students' experiences (self-oriented). The findings of this final product analysis are reported separately (Bosch et al., 2021).

'How did design empathy manifest in the students' end-user-related design episodes?
The second research question focused on analysing how design empathy and its different dimensions were manifested in the students' end-user-related design episodes. Notably, when the students discussed the many end-user-related aspects, empathy was present, as we consider end-user-related discussions the result of applying empathy in the process. In the following paragraphs, we present our findings through selected illustrative examples, adapting the chronological design process.

We utilised four categories to analyse the dimensions that indicated empathy: PE, SE, EI and SA. The empathic design process started with the first design phase – empathise – during which the students produced empathy maps by thinking about and recalling what today's kindergarteners feel, make, play, fear, think and dream about, alongside their own experiences of kindergarten eight years ago. This was the starting point for encouraging the students' motivation and receptiveness and triggered their *EI* in the kindergarteners. A cognitive connection with the end users was established, and later, the connection deepened when the students learned about the users and attuned to their situations on several occasions. In the next vignette from Session 3, two students from Team 2 are remembering their kindergarten visit (on Session 2), as they are ideating solutions to the 'How might we...' questions that the researcher has put together according to the user research.

> *Iina: 'What was the idea behind the Strength Crow there [in kindergarten] in the first place?'*
> *Senja: 'Didn't they have to choose a strength each week, so then on Valentine's Day, they had love and friendship?'*
> (Team 2, Session 3, Episode 5)

The session, with an actual visit to the kindergarten, observations of the space and objects, and interaction with the end users, promoted *SE*. The eighth graders were affectively attuned to and in contact with the kindergarteners, who told them about their everyday life and experiences in kindergarten. In the beginning of Session 3, a student from Team 1 remarked, 'Like, it is nice to be with those kindergarteners, or they are cute.' Real contact and interaction with the users at the later stages supported this affective dimension in order to be sensitive to the learning aids and features that really served the end users.

During the defining and developing sessions (3–5), the students brainstormed and generated design concepts and applied empathy by imagining the designer's self in a user's position (SA) and the user's self in a user's position (EI). They utilised empathic capacity by thinking and discussing about what the kindergarteners felt or how they would feel as kindergarteners. This was a sign of *SA*, as it required the students to distinguish between the self and the other and to understand that they, as designers, were serving the other. The students discussed and reflected on the situation in kindergarten and then developed the design concepts accordingly.

The students referred to their previous *PEs* in the kindergarten context, sometimes indirectly by knowing certain practices from kindergarten. An example is shown in the next vignette, when they consider the games that could be played in the kindergarten when it is dark, but they realise that the children are there during the daytime.

> *Emmi: 'To me, [what] comes to mind [is] some kind of… these would be eyes in the dark.'*

Sofia: 'Oh yeah, that would be scary.'
Emmi: 'Yeah, playing some ambush game in the garden. They just don't have any games in the dark.'
Sofia: 'Except if they come in the morning very early... so then.'
(Team 2, Session 3, Episode 17)

Sometimes, they directly refer to their previous *PEs* by stating what they did or enjoyed in kindergarten.

Senja: 'I was just wondering, Iina, you were at the forest kindergarten. What was the best part of those trips to the forest?'
Iina: 'Eating.'
Senja: 'Yeah, in my opinion, eating was always the best. We went on trips to the forest, too.'
Iina: 'Well, so, there were not so [many more] ... and playing in the forest.'
(Team 2, Session 3, Episode 3)

Later in the process, other-oriented EI and engagement were visible, as both teams wanted the ideated solutions to be desirable, usable and relevant to the end users' needs. SE was present, for example, as empathic concern about the children's safety when using the product so that they would not get hurt. In the next vignette, a student from Team 2 confirms that Velcro is a safer choice than pins for kindergarteners to use.

Senja: 'Did you get any other ideas?'
Rosa: 'Well, I got the idea that we could do the base with the Velcro, and every week, one strength [card] could be attached to it.'
Senja: 'Yeah, that's a good idea. Cause with [sharp] pins, they [the kindergarteners] get entangled and prick themselves.'
(Team 2, Session 4, Episode 4)

Concepts were generated based on the students' experiences and knowledge of the (rather familiar) end-user group and context. They conducted the research together with the teacher and the researcher by observing and interacting with the end users. The students synthesised their knowledge from the prior context to meet the desired design brief criteria and evaluated their design concepts with and for the end users. This cognitive and affective mirroring and reflection between the self and the other required the presence of several empathic dimensions in some episodes. Next, we provide two illustrative examples of the episodes involving Team 1, where different dimensions of empathy are intertwined, and different dimensions are visible.

The first example is from Session 3, in which the students ideate solutions for the end users with 'How might we...' questions. In this episode, the students brainstorm about the need to have a livelier season tree in the class, as the previous one was a flat brown cardboard tree. They refer to other-oriented features and cognitively attune to the user context (EI) by thinking about whether real branches survive inside the classroom. However, during the episode, the students also use their relevant experiences (PE) and knowledge of manufacturing and

contribute this knowledge as part of the feature that helps the children decorate the tree themselves (EI).

> *Emmi: 'Like, what if there were some different [items] to pin onto it. Some flowers and leaves made of fabric and...'*
> *Sofia: 'Branches could be pinned onto it from outside... If they will stay good.'*
> *Emmi: 'Oh yeah, yeah, get some branches. Like, real branches.'*
> *Sara: 'And then according to the season, in the fall, there could be like dark leaves and then in the summer, some green.'*
> *Emmi: 'Yeah, change them.'*
> *Sara: 'Yep.'*
> *Emmi: 'You know, those could be like Velcro, like fastened on.'*
> *Sara: 'But I don't know how well it would work if they're made of fabric; one would need to make some kind of Velcro surface.'*
> *Emmi: 'Yeah, but one just like that – well, you didn't participate in the planning of the Xmas play – but kind of like stickers that were made for some of the costumes, or those northern light things that were fastened with the same kind of stickers.'*
> *Sara: 'Yeah. Then we could use that or then.'*
> *Emmi: 'Yeah, then they could decorate the tree themselves.'*
> (Team 1, Ideation Session 3, Episode 7)

In Session 4, the students prepared for the presentation and feedback session (Figure 3). During this session, Sara showed empathic concern (SE) when worrying about whether the kindergarteners understood the mock-up version and the idea behind the concept (EI). The other team members were supportive, and together, they imagined how kindergarteners would think (EI). They expressed SA and their inner and outer reflections by considering how their refinements could help the children understand the design concept (SA). When Sara reflected on the birch leaves and suggested a good way to help the kindergarteners understand them, she also recalled her relevant experience (PE) on the topic.

Figure 3. Team 1 preparing for the presentation and feedback session.

In the second example below, all Team 1 members are cognitively attuned to the kindergarteners; they are interested in and motivated to learn about the end users and to ask for feedback (EI). Especially, Emmi expresses affective emotion (SE) related to this end-user connection at the end of the episode. Additionally, she tries to predict what the kindergarteners might want but simultaneously shows awareness (SA) that this might be something different from what she thinks. The following example is from the episode where the students plan the short presentation for the kindergarteners, as they will soon arrive for the feedback session.

> *Emmi: 'By the way, we can show this [points at the mock-up], like here it is. Or I don't know…'*
> *Sara: 'Yeah, can't we show this, too?' [points at the mock-up]*
> *Sofia: 'Yeah.'*
> *Sofia: 'Then, in the end, we can ask if the tree should be larger or if it is a good size. And then...'*
> *Emmi: 'I think that they might even like this one, or then they might want something really big; I don't know.' [places leaves on top of the tree prototype]*
> *[...]*
> *Sofia: 'Should we say that they could use real branches?'*
> *Emmi: 'Dunno. We could ask if they want real ones or something else.'*
> *Sara: 'Yeah, we could ask.'*
> *Emmi: 'Don't know why, but even though they [kindergarteners] are like little, it makes me nervous to go there [and present the design].'*
> (Team 1, preparing for presentation and feedback, Session 4, Episode 10)

EI and engagement in the project and SE towards the end users were also visible when the students tried to develop the concepts and to combine the season tree and the crow according to the end users' wishes and feedback. The students wanted to please the end users, and they were concerned about whether the kindergarteners would like and be able to use the products.

These examples demonstrate how signs of empathy and its different dimensions appear in the design process, and how these are expressed by the students. We found evidence of all four dimensions in all the analysed sessions, so both cognitive–affective and self–other dimensions played a part in the process. The students showed EI in the end users, as it was the most common empathy dimension visible in the data and was coded almost twice as many times as the next visible dimensions – SA and PE. SE played a role but was the least coded dimension. All of the empathic dimensions were entangled, and it was rare to find only one dimension per episode.

Discussion

The findings of this exploratory case study suggest that eighth graders could practise empathic design by acknowledging end users in multiple concrete and abstract ways throughout the process. Signs of empathy are found in various end-user-related discussions and empathic considerations, resulting in end-user-friendly and meaningful materialised design products (see Bosch et al., 2021). The examples of the eighth-graders' end-user-related discussions present different design aspects and features that are concrete and simple in nature.

Direct contact and interaction with real end users are effective in increasing students' motivation and engagement (Smeenk et al., 2019; van Rijn et al., 2011), and many researchers have suggested autobiographical experiences, allowing designers to be sensitive to users (see, e.g., Van Rijn et al., 2011; Smeenk et al., 2016; Hess & Fila, 2016). In the study of Voigt et al. (2019), empathy depends on children's ability to connect with the problem definition at a personal level. We surmise that with adolescents or younger children, direct contact and the students' own previous experiences of the context are crucial for motivational reasons and in making the whole design process more concrete and being able to apply different perspectives in design. Everyone has an experience of kindergarten and its practices, and these constitute the important connector between the students and the end users.

We have identified all four empathy dimensions (EI, SE, SA and PE) in our dataset, but empathy has proven to be challenging to analyse due to its nature. Furthermore, different dimensions are easily intertwined in episodic discussions, suggesting that different perspectives (MPs) are taken during the process. This confirms earlier studies' findings that empathising in design is a dynamic and relational process, including affective experiences and cognitive processes that move across and between the self- and the other orientations (e.g., Smeenk et al., 2019). Nevertheless, this framework has not been previously used to analyse video data of the long-term open-ended design process, so comparison with other studies is difficult. Moreover, earlier studies on empathy in design at the primary and the secondary education levels have mostly used interview, design artefact, questionnaire and/or field-notes data (see e.g., Demetriou & Nicholl, 2021; Kijima et al., 2021; Van Mechelen et al., 2018). We consider our research as offering new perspectives and insights on studying empathy in design in primary-level and secondary-level education, bringing value for researchers in the fields of both the learning sciences and the child–computer interaction, where the various roles of children in PD are discussed repeatedly (see, e.g., Schepers et al., 2019).

The eighth graders' ideated concepts had to be materialised and the products manufactured by the students themselves; thus, during the process, they referred to their previous experiences in sewing or coding. The process reveals that empathy functions together with these non-empathic elements, such as functional or technical considerations. Hess and Fila (2016) report similar findings in their studies. This might have affected the overall design process, as certain manual or digital manufacturing skills or material constraints existed.

Although the design process is a dialogic process between teachers and students, this study has focused on verbal design discussions among the student team members. When we consider the conditions and the factors that enable the empathic considerations and perspective taking, we must emphasise certain design tasks, asking questions and continuous design facilitation by the researcher and the teacher. Both the teacher and the researcher had earlier experience in craft and design education, which supported this facilitation process. We will analyse the pedagogical arrangements and conditions in a separate publication, so here, we have focused only on examining how empathy is manifested in students' design discussions.

The sample size of this small case study is limited but suitable for this kind of pilot project. To increase this study's reliability, we have offered an overall picture of the process implementation and described and justified the data collection methods and analysis as precisely as possible in a single journal article. To alleviate possible concerns about researcher

objectivity or possible biases in analysing the data due to familiarity with the context, we have kept detailed field notes and actively used reflective practices. Due to the small size and situated nature of this study, it cannot be generalised, but the results pave the way towards new studies on empathic PD with a larger group of attendees, in different schools and grades.

The students gave their permission for the data collection, but as this project was part of formal education, participation was not voluntary for them. This, and given that the project class was held at 8 AM every Friday and the students were teenagers, could hinder some students' active participation. We noticed that the students felt some time pressure while trying to complete the products. However, a small student–teacher ratio allowed enough time for instruction, which was necessary due to the time limits of the project.

This project's main educational goal is to teach students about the PD process and empathic perspective taking, and its focus is on students' design processes, not on kindergarteners' participation. Furthermore, the end users' preliminary needs or challenges are expressed by the kindergarten teacher. The children's feedback is highly concrete in nature and focuses only on certain very simple features, such as the product size or the colour of the LED lights. In future studies, to follow the PD ideology on user involvement more profoundly, researchers might want to pay attention to even more collaborative and playful methods of gathering insights from children. Nonetheless, this would need much more time than we have had for implementing this project in formal craft education in a Finnish school.

This study's findings broaden the knowledge of how empathy is manifested in lower secondary school students' design and making process. The value of involving end users in this participatory process lies in learning different 21st-century attributes (here, empathy) and in producing design outcomes (here, meaningful products). We suggest that design, maker and STEAM education as an international field could pay more attention to including end users and communities in PD projects using suitable and systematic approaches, offering ways for students to develop empathy, as well as learn (digital) design literacy skills. This could induce an increased level of awareness about people's life circumstances and needs, thereby creating value in both learning and design outcomes.

Accordingly, we need future studies on how these community-based participatory and empathic practices can be implemented in formal education, for example, how teachers design and support PD projects, balance the process with structure and freedom, and assign students certain tasks to feed implicit learning goals (such as different 21st-century skills) into the process. Based on Sultan and colleagues' (2019) review on improving girls' engagement in technology, the social context has to be adapted to girls; here, empathic and community-based design could offer a way to do so (see also, e.g., Holbert, 2016; Kijima et al., 2021).

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