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Contextmapping in primary design and technology education: a fruitful method to develop empathy for and insight in user needs

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Abstract Human-centered design is of growing importance for professional designers and in the past two decades a series of techniques for designers to develop understanding of and empathy with a diversity of users has been developed within this field. In the second half of the twentieth century, intended users were involved late in the design process, i.e. during the testing of products or prototypes. More recently, the user is involved in the early phases, when the direction is set. Users have rich local contextual knowledge and can work together with professional designers. Although these techniques are now entering mainstream design education at the university level, they have not yet reached Design and Technology Education in primary and secondary schools. Most teachers do not yet provide opportunities for pupils to conduct research to uncover the needs, wishes, and experiences of specific user groups. However, this understanding of users belongs in D&T education, because artifacts have a dual nature: a physical and an intentional nature. In this paper we describe a Contextmapping method for pupils (aged 9–12 years) and illustrate this with a design project. The assignment for the pupils was to "design a playground in which children and elderly people are active together" in which the pupils developed an understanding of elderly people through Contextmapping.

Keywords Human centered design · Primary education · Contextual user research · Contextmapping

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Introduction

Human-centered design

Considering the needs of users is becoming common sense in professional design projects. Designers take into account the needs and wishes of users and are more and more aware of the fact that they design for a diversity of users. In this way, they acknowledge the dual nature of technical products. Products have a physical and an intentional nature (Kroes 2002; Kroes and Meijers 2006). On the one hand, a product is defined by its physical characteristics; on the other hand an object derives its social meaning from its users. In order to call an activity 'technological', there must be the users' role (Kimbell 1994: 250). The following example illustrates this: a rock is not a technological object when it is just lying in a river. However, when some one recognizes it as a hammering instrument to put up a tent, the stone becomes technology. The stone gets its social meaning through its purpose and function for the user.

It is these latter meanings which justify our developing of products, and for which understanding the user is crucial. Designers need knowledge about and have to develop empathy with the people they are going to design for. Traditionally, users were only involved in the later stages of the design process during the testing and evaluation of products. However, in the early stages of a design project, where the context is explored, requirements are defined, and ideas for solutions are developed, everything is still open and hardly any choices have been made yet. It is at this stage that user input can have the greatest impact in ensuring that successful products are developed. But asking users about their wishes and needs is not as straightforward as showing them a product and asking what they do or do not like about it. In Human-Centered Design joint design and research activities of professional designers and laymen take place from the start of the project, throughout various cycles (Maguire 2001).

Users are acknowledged as important experts amongst other experts in Human-Centered Design. They are the ones with rich contextual knowledge. Quite often, users have knowledge that designers and other experts lack. This is especially true when the target group, e.g. the ageing population or low-income groups, leads a different life than the professional designers. Although they are laymen in design, they can contribute tremendously to the design process. When sharing their experiences in ways that designers can use, users share insight in their local context, their wishes, needs and dreams for the future.

Contextmapping

To develop empathy with and get inspiration from users at the beginning of a design project, designers can perform Contextual User Research. This is an empathic, qualitative and design-driven form of research, which gives insight in the daily life and experiences of potential users. At the TU Delft a procedure called Contextmapping, has been developed to conduct contextual research with users (Sleeswijk Visser et al. 2005).

The basic principle of Contextmapping is that 'users are the experts of their own experiences' (Sleeswijk Visser et al. 2005), but this expertise lies in deeper levels of knowledge, which we are not immediately aware of, structured, or expressed in words. Therefore, generative techniques are used to guide participants in small steps through the process of accessing and expressing these deeper levels of knowledge. In Contextmapping participants first get a number of small assignments in which they observe and reflect on a certain topic in their lives during a couple of days. Next, a few participants come together

for a generative session and are given some creative assignments, in which they make something and then talk about it. Where other tools focus on the meaning, utility and usability of existing products or prototypes, Contextmapping is a much more open approach to collect stories to get insight in the experiences, dreams and needs of people.

Concluding, in order to address the intentional nature of technology, professional designers can include the user perspective in the early stages of the design process. They seek for understanding and empathy by including unique personal stories and experiences of layman through joint design projects or contextual user research. In the next section we will see how this important principle of Human-Centered Design has been adopted within the context of design and technology education.

Human-centered design in primary and secondary education

Among professional designers, attention for the user has been growing in the past decennia. Is the same happening in Design and Technology Education? Do teachers and curriculum developers recognize the inclusion of the user-perspective in the D&T curriculum as important? Is it possible to include the user-perspective in classrooms? As we will show, this differs from country to country.

The Netherlands

In the Netherlands, Science and Technology is a relatively new area in primary education and has been introduced in the curriculum in 2002. Since then policymakers have focused on implementation of science, technology and design in schools. First, only by supporting early adopters by establishing networks and providing financial means for curriculum experiments and diffusion of the results. In 2004 the Ministry of Education, Culture and Science and two other Ministries decided that one third of the schools had to implement the new subject (MECW 2004). Many schools took up the challenge and were supported by a network of expert organizations. In 2008 policy makers realized the need for further professionalization and approximately 5,000 teachers received a free training.

A key idea in the Netherlands is that pupils' activities should mirror the activities of professional designers and scientists. Schools should provide their pupils opportunities to develop a research and problem-solving attitude starting at age four (Boeijen et al. 2011). Inquiry based learning in authentic situations is advocated. Context-concept based approaches are implemented in the Dutch primary schools and also in the secondary schools (Eijkelhof and Krüger 2009).

The official goals of the D&T education have been formulated in a number of policy documents. The two core objectives that are related to D&T are (MECW 2006):

44 Concerning products from their own environment, the pupils learn to find connections between form, material use, and the way things work
45 The pupils learn to design, realize and evaluate solutions for technical problems

In 2011, a more detailed description of the goals and content of D&T education has been made (Boeijen et al. 2011). Boeijen et al. advocate the use of a design cycle with stages to structure the learning and design processes of pupils and mention four stages:

- Signaling, analyzing and describing a problem,
- Developing a Design Proposal and adapting it,
- Making a Product/Prototype,

- Evaluating, Testing and Improving the design/product.

For each design stage the main activities, competences and knowledge areas have been described but 'user', 'needs' or related terms are not mentioned. Only two minor references to the social aspects of design are made. From this, it is clear that Dutch policy makers focus the learning mainly on the physical aspects of the design process, as they do not clearly state the necessity of considering users in design processes.

However, the Dutch educational system does provide opportunities for human-centered design. First of all, the design cycle and a concept-context approach are advocated in primary and secondary education. In concept-context learning, real life problems are used to gain insight in abstract concepts (Koski et al. 2011). This facilitates the inclusion of the user-perspective. Secondly, the integration of design and technology with other subjects such as geography, history, math and languages are advocated in primary education (Van Graft et al. 2014). Although this is partly stimulated to make room in an over-crowded curriculum, it makes it possible to include the human factor in design projects.

England

In England, the intended curriculum does include the user-perspective. For Key Stage 1 (pupils aged 5–7 year): "Pupils should be taught to generate ideas drawing on their own and other people's experiences" (www.eudcation.gov.uk)." For Key Stage 2 (pupils aged 7–11 years) the goal related to the user-perspective is "Pupils should be taught to generate ideas for products after thinking about who will use them and what they will be used for, using information from a number of sources, including ICT-based sources".

The intended curriculum for Key Stage 3 (pupils aged 11–14 years), acknowledges the importance of the user and the social function of products; see Nicholl et al. (2012) for a more extensive review of the policy documents. "In Design and Technology pupils combine practical and technological skills with creative thinking to design and make products and systems that meet human needs" (QCA 2007: 51). As part of the design process "pupils have to develop an understanding of user's need and the problems arising from them" (QCA 55). The critical evaluation is also related to the user: "Evaluating the needs of users and the context in which products are used to inform designing and making" (QCA 53).

Policymakers are aware that considering users' needs when designing and making products is an important skill to acquire (Nicholl et al. 2012) In all Key Stages, pupils have to include the user-perspective. This should start in the early stages of the design process and continue during designing, making and testing. However, the learning goals and way the user is included differs. For the pupils aged 5–7 years, the policymakers consider the pupils own experiences as a starting point. This is in line with the developmental stage of these pupils. Teachers should provide pupils with opportunities to develop their own hands-on experiences with products so that they can understand and communicate their own wishes and needs. A next step is to become aware of experiences of other people. For these young pupils it is important that teachers select design projects closely related to their own local contexts with research on users the pupils are closely related to, e.g. their grandparents, house pets or the butcher next door.

Using a storytelling approach with figures they can easily relate to can be a fruitful way to establish empathy and the motivation to solve problems for other people. Stories are a great way to learn in schools because stories improve comprehension due to the many

details (Haven 2007). Researchers who apply Contextmapping are also "storytellers", e.g. results are often presented in the form of storyboards.

Starting from Key-Stage 2, policymakers expect pupils to design products and solutions for people with other needs, capabilities and experiences, for example the ageing population. The policymakers restrict the research on users to thinking and the use of secondary, internet sources. This is not necessary. Looking at their developmental stage, we assume that pupils at this age are motivated to discover human-centered design and able to apply the same kind of research strategies as applied by professional designers, e.g. Contextmapping. As Nicholl et al. (2012) argues, we can only speak of authentic learning in Design and Technology when pupils develop local and specific knowledge of the people they design for.

The case study of Hill (1998) is one of the very few examples of design processes in education, in which the user is included (Nicholl et al. 2012). In the study, a secondary student designs a table for people at a retirement home. The student visits the retirement home several times, has discussions and decides to make a table from concrete and steel. After numerous sketches and drawings and the production of a small-scale model out of wood, she visits the residents again. At that point she finds out that the people at the retirement home did not want her design because it would tear and hurt the residents skin. This was frustrating for the student: "And then I found out that they didn't want that at all. I can't remember what the reason was for not wanting the design. It was kind of disappointing because I had at least 20 drawings for them. And they did not want the design." (Hill 1998, p. 213).

As part of the D&T curriculum, teachers should stimulate the direct interaction of pupils and users. However, as the case study with the retirement home shows, it is not easy to collect information on the user needs and dreams in an early stage of the design process. Students may easily start to design solutions before they understand the situation from the user-perspective. Although the information on including the user perspective in primary design and technology education is limited, we assume that pupils in key-stage 2 can apply the same kind of tools as professional researchers use. However, experience with these tools in educational settings is lacking.

In the next section, we describe the development of an educational tool based on Contextmapping.

Case study

In this section, we report on a case study where pupils, aged 7–12, are asked to design a "movement-garden" in which elderly people and children move together. They take on the role of researcher and apply a Contextmapping related tool to gain knowledge of, and empathy with, the way elderly people move.

Assignment

For the pupils, the goal of this project was to come up with innovations to place in a new playground, in which children and elderly can be active together. Towards the pupils we used the term "movement-garden", to make sure that they would come up with new inventions, instead of traditional playground equipment. This assignment was related to the ProFit project, which is funded by the European Union, under the Interreg IVB North West

Europe program. Within this project the "playground" will be realized in the form of a field-lab (profitproject.org). The relation to this real-life project made the assignment very concrete. For example: the pupils visited the actual location of the future playground, which is positioned next to an elderly home and in close reach of multiple schools and family houses.

Collaborators

In this case study we investigate opportunities to put pupils in the role of researcher. Figure 1 shows a designer or researcher who trains a pupil to conduct contextual research with someone in his direct environment, in this case his grandmother. The pupil can be seen as a collaborator who performs research with somebody from the intended target group: a source. This approach is related to Contextmapping, as it uses some of the same principles: seeing the user as the expert of their experiences and making use of generative techniques.

Design benefits: professional designer

The original goal of this case study was design driven; to find out if pupils are able to do interviews and extract valuable insights as research collaborators in order to contribute to the design process (Van Doorn 2013). Therefore the pupils took on the role of collaborator; researching their peers and their grandparents. Expectations were that the pupils would be able to collect rich contextual insights, since they are closer to other interesting research participants, both geographically and socially, and since within the same target group, people speak the same language and share a contextual world (blue/light grey border in Fig. 1). In general, people have different interactions with their peers than with a researcher. A returning issue within qualitative research is the development of rapport, or mutual understanding and fellowship. By using people who are close to each other to conduct a research, rapport is already there. The collaborators might even become a "super sources", delivering other insights than "normal" participants, possibly because these pupils feel more connected to the project.

Participatory design with children

In Participatory Design, users are working actively together with designers. Participatory Design has been conducted with children (Read et al. 2002) and several methods are

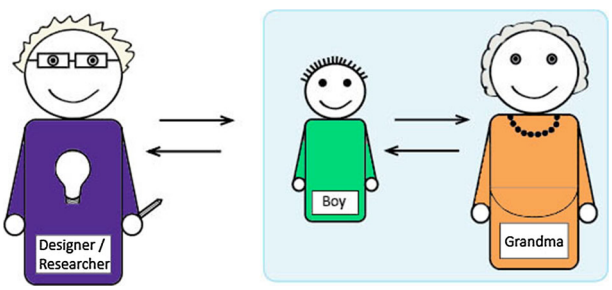

Fig. 1 Using collaborators to conduct research

developed to enhance the process for a younger target group. Druin developed "Cooperative Inquiry" (Druin 2002), a design approach building on participatory design and contextual inquiry, to let children participate in the development of technology. Within Cooperative Inquiry, children and adults participate together in intergenerational teams. They visit other participants in their own environment, conducting interviews and leading discussions.

Educational benefits

Although this collaborative research method was developed for design purposes, we foresee strong educational benefits as well. The pupils are stimulated to develop knowledge of and gain empathy with a different target group, e.g. the ageing population. They will experience the diversity of this group when pupils share their interview-results with other pupils. As they compare the experiences and needs of elderly people with their own situation, they will discover similarities and differences and get a deeper insight in their own situation. During the process, they learn to ask questions and become better listeners. The goals that we want to achieve are the following. Pupils:

- gain empathy with a target group that is different from them.
- discover similarities and differences with others.
- learn to ask questions to people from outside their peer group and become better listeners.
- learn to share and synthesize their findings from the interviews.
- generate ideas drawing on their own and other people's experiences.

Case study scenario

The scenario shown in Fig. 2 served as the basis for this case study. This scenario includes a training of the pupils, a practice round, the collection of data by the pupils, a moment of reflection and a feedback session in which the pupils share their insights and draw conclusions. The final step was a creative session in which the pupils translated their research findings into ideas.

Limitations

As seen in Fig. 2, this project ended with a creative session to think of new ideas. In a next research project, it would be interesting to take the method further into the design process; to send the pupils back to their participants with the ideas they came up with in order to get their opinion.

Procedure

Twenty pupils, aged 9–12, from a primary school in the city of Delft participated in this project. For them, the goal of this project was to come up with ideas for a new playground in which children and elderly can be active together. The entire project consisted of four sessions with the pupils and the individual conduction of the interviews; the content of each session will be explained in this section. The group sessions and the interviews the pupils conducted were audio-recorded and transcribed in order to gather insights about the used method. The project was directed and supervised by one researcher.

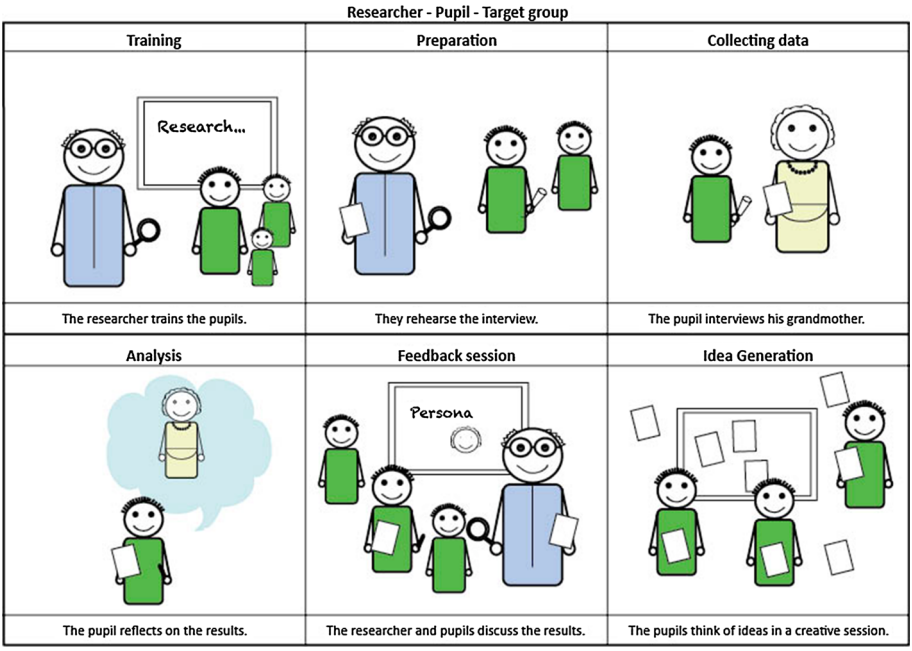

Fig. 2 Scenario

Session 1: research questions

In the first session, after the project was introduced, the pupils sketched ideas for new playground equipment; to be used by pupils and elderly together. They found out that it is hard to think of ideas that are not just for you, but also for other people. The next step was to find out what the needs and wishes of the intended target groups are. The pupils were divided into small groups, either focusing on peers or on elderly. Within these small groups they thought of questions to ask their target group and gave input for the development of a research booklet (Fig. 3).

It turned out to be hard for the pupils to come up with questions individually. By making it into a group process and challenging the group to come up with a certain amount of questions, they let loose of their boundaries, inspired each other and came up with a lot more questions.

With the input from the pupils, the researcher developed two different research booklets (one for interviewing pupils, one for interviewing grandparents). These booklets are a mix of creative assignments and interview-questions the pupils came up with. The booklets are meant as a conversation starter and a way to structure the interviews pupils are going to perform with either friends or grandparents.

Session 2: training

In the second session the pupils came together in small groups again, to give their feedback on the research booklets. They were mostly concerned about the appearance of the

Fig. 3 Children thinking of research questions

booklets. One content adjustment the pupils suggested was the addition of a blank space for a question of their own choice, which they could come up with during the interview. Although not all pupils used this question during their interview, it added to the feeling of ownership and occasionally gave an interesting insight. Overall the pupils were excited to start working with the booklets:

> Boy: "This booklet looks really cool…. I'm already looking forward to doing the interviews!"
> Boy: "I don't really have adjustments, we are just going to do it, just give it to them!"

After the discussion of the booklet, the pupils received a short training to prepare them to conduct the interviews. During this training the pupils got some interview tips and they rehearsed the interview on group members (Fig. 4). This last part was the most useful; they learned by experience and only when practicing did the pupils show if they really understood what to do.

> Boy: "This booklet has enough in it to discover a lot. Some people need a lot of questions to get to know one thing. With this booklet… after two, three questions you know something already."
> Girl: "I think sometimes you can spend an hour on only this first question."

One of the interview tips during the training was to ask the participants to think aloud. The pupils picked this skill up very quickly and used it during the training as well as during the actual interview. Another tip was to use a pause every now and then to challenge participants to share even more. This tip was recognizable for several pupils. "Sometimes when somebody asks me a question, I don't know the answer. But then a few moments later I remember again!" It is valuable to relate the interview skills to the pupils' own experience and then practice them on each other.

Half of the groups interviewed friends from their own age and the other half interviewed their grandparents. The interview with friends was easier to practice, because the pupils answered the questions as themselves. When rehearsing the interview with grandparents, the pupils pretended to be elderly. At first there was a lot of giggling and funny acting but

Fig. 4 Rehearsing the interview

along the way it was striking to see that they realized how little they actually knew about their grandparents and started to become curious about what their real answers would be.

The training sessions were performed in small groups of 4 or 5 pupils. These groups worked very well; during the training they gave each other tips on how to improve their interviewing skills. The groups worked very seriously and when one of the pupils misbehaved, the rest of the group reprimanded him. There was a lot of discussion within the groups about the research subject. Some of the pupils knew each other well, which gave another dimension to the practicing of the interviews; they could add to each other's answers and dive deeper into some of the subjects.

- Question from booklet: With whom do you play with and what do you do?
- Girl answers the question
- Boy to girl: "I thought you also play most with Bobby right? Isn't that true?"
- Girl: "Yes that is right, I play a lot with Bobby, my sister, I didn't think about that, I thought you meant friends not family."

Conducting research individually

Over a period of 2 weeks, the pupils went to interview their peers or their grandparents individually. Only one pair of boys chose to do the interviews together. Some examples of pages from the research booklets can be found in Fig. 5.

Session 3: analysis/personas

Subsequently to conducting the interviews, the small groups came together for a feedback session in which they discussed their results. After sharing their experiences, the groups filled in templates of personas as a kind of summary of different kinds of participants they encountered (Fig. 6).

By making the personas, the pupils integrated information from the different interviews into one story. The process of filling in the persona was done within the small groups and every group was lead by the researcher. Together they started with an empty template and the first step was to come up with a name and age for this new fictive character. By asking

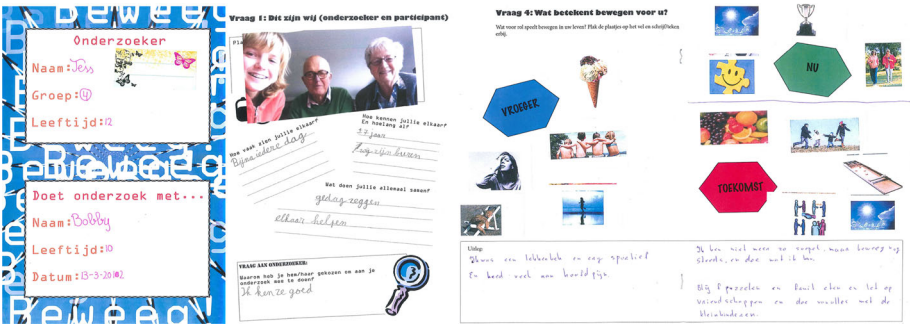

Fig. 5 Pages from research booklet

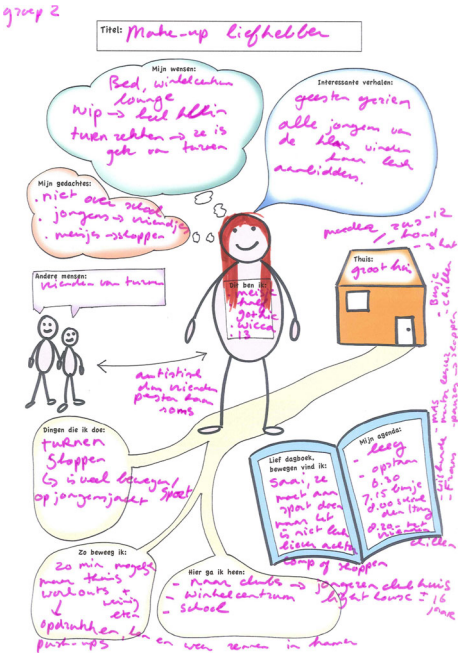

Fig. 6 Example of filled-in persona template

the pupils for the ages of their participants and choosing one in the middle, the children got the idea of combining real data into one coherent story. After giving this persona a basic identity (where he lives, what he looks like, etc.), they started thinking about his activities, wishes, thoughts and stories. Somewhere during this process, the pupils thought of a title to give to this persona, summarizing the most important characteristics, for example ‘somebody who is active and loves nature’ or ‘a make-up lover’.

The personas worked well, the pupils thought the templates were inviting and wanted to start right away. When making the personas and combining several participants into one character, some pupils were more comfortable to share their experiences. When using personas they didn’t have to talk about a specific participant so they didn’t feel like

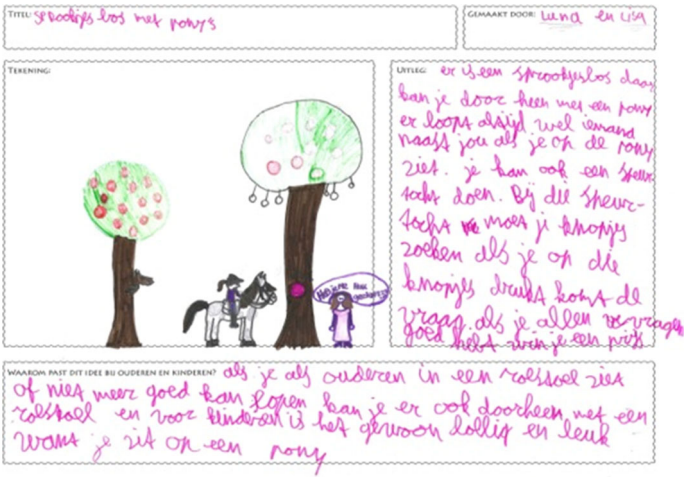

Fig. 7 Example of a generated idea

betraying this person and the insights were more anonymous. For example when the pupils were making a persona about an old grandfather one boy added:

He moves in order to meet people, he is kind of lonely.

It is easier to say something like that about a fictive character than about your own grandfather.

By making the personas within small groups, everyone could add to the discussion in their own time, this gave an energetic and positive atmosphere. It turned out that the pupils were capable of comparing persons very well; they are able to see the differences and similarities between people and to make a short description of a certain character. In the end, the descriptions of the personas were much more elaborate than the description of the individual participants.

Finishing the personas marked the end of the research phase. At the end, one girl wanted to fill in a persona about her own grandparents to keep at home. Like a memorabilia from the research, feeling proud of what she had achieved.

Session 4: creative idea generation

In a final creative session, the pupils thought again of ideas to place in the new playground, but now with the use of their personas and their gained knowledge about the target group. The whole class participated in this session at the same time and new groups were formed to generate ideas together, each group combining pupils with knowledge from the two different target groups. We feel that the ideas from this generative session were more empathic towards elderly than the ideas from the first session. One signal for that is that the drawings from the first session often didn't include any persons. In the final generative session almost all groups draw persons and they explained more about the roles and wishes of these different persons (Figs. 7, 8).

Some first adjustments to the method are tested in another project with 27 twelve-year-olds at a Dutch high school. In this project the pupils had more influence on their research.

Fig. 8 Idea presentation

Their target group was the elderly, but the exact research topic was their own choice. Some groups investigated loneliness, others medicine use, communication, etc. Their final goal was to design something meaningful that fits the older population. This enables pupils to signal and select a design challenge that develops from the interaction with users. The process becomes more dynamic and iterative compared to a pre-defined challenge.

Conclusions

Our case study shows that it is possible to develop methods for human centered design that can be applied in primary schools. Pupils aged 9–12 are able to use interviews and personas to collect, analyze and synthesize information on the lives, needs and wishes of users. The method enables pupils to communicate with the user in a more open manner; the focus is not on products, but on experiences. We assume that this enhances the quality and the creativity of the design process and it's results.

When pupils explore the experiences of the users first hand, they may notice other things. A number of research findings from the pupils differed from average ideas about the elderly. For example, one of the personas, Jan, aged 74, dreamt about learning to climb again. The pupils also gained new knowledge about their participants, bringing them closer together:

> My grandfather told me that he used to play soccer a lot, and all kind of things he did when he was a child, building huts for example! Usually he doesn't share these kind of things.

Developing empathy

At the start of this project we foresaw a number of educational benefits for the participating pupils. During the project we found that most of these benefits were realized. Through well-prepared contact they gained empathy with a target group that is different from them. By asking questions and listening carefully to the answers, the pupils discovered similarities and differences between and with elderly people, but also between them and other pupils. Other educational benefits were:

- While conducting interviews, the children gained new knowledge about people close to them.
- They were able to synthesize the collected information and developed mental images that respect the diverse target group.
- After conducting the research, the generated ideas were more considerate to the needs and wishes of users than at the start of the project.
- They used their own personal network to arrange participants and in some cases strengthened their family bound.

Research skills

The pupils showed, during this project, that they can be skillful researchers. They were good at asking questions and follow-up questions: Some children were very determined to get to the bottom of things. They took their role of researcher very serious and that reflected on their participants, especially the elderly, who answered most of the times very serious and elaborated. The use of voice-recorders strengthened this role and added to the feeling of professionalism.

During this project they practiced a great number of social and analytical skills. An example of this is that they came up with appropriate questions to get to the knowledge they needed. Next to that, they were good at summarizing and derived conclusions and actions from these summaries.

The level of skills as well as the thinking abilities of the children varied. The difference was partly due to age. One example of the difference in thinking level can be seen in the following answers from two different children:

> Researcher: "Ok, what would this person write, dear diary, I think moving is…".
> Boy (9): "Super cool! Supersonically cool!"
> Girl (12): "A lot of fun because you can see everything around you. When you sit alone and still in your room you don't experience much."

In our case study, the differences in thinking level and the ability to put yourself in someone else's shoes were partly overcome by mixing the ages within the groups, so younger children learned from the older ones. The project shows that pupils aged nine are already able to use formal methods such as interviews and personas to gain knowledge on their peers and elderly people.

Success factors

A number of aspects are especially responsible for the successfulness of the method:

- Becoming Curious: By starting the project with thinking of ideas for the "movement-garden" and subsequently asking the pupils what elderly would think of their ideas, they find out that they are missing knowledge and become curious. By practicing the interviews they also become curious about the real answers elderly would give.
- Early in the Design Process: Placing the encounter with the target group at the beginning of the project forces pupils to gather insights before developing elaborated design ideas.
- Guidance and Security: The formal method gives the pupils structure. It is scary to do the interviews, by giving them the step-by-step guidance they felt more secure.

Practicing the interviews improved the pupils' interview skills and they got familiar with the procedure.

- Ownership: Letting the pupils think of questions themselves and incorporating their contribution into the research booklet gave them ownership. The research booklet appealed and gave motivation.
- Authentic task: Letting the pupils arrange their own participants was valuable; finding them, setting a date and taking action was good to practice. Using participants that are close to them enables the pupils to practice in a safe environment. When the pupils finished their interviews they were proud and really liked it.
- Cooperation: The team-members had a joint commitment. During the group meetings, they shared knowledge, were focused on the task and supported each other to come up with a good design for the neighbourhood.
- Synthesizing information in Personas: The personas were an easy way to get the most valuable insights together into a story the children could work with. The personas were build-up with all group-members together. Everybody contributed to them, instead of making individual ones, which made the personas much richer. By making the persona together they all felt connected to the persona they were going to work with.

Improvement of the method

Although the developed method for co-research by children was successful, even better results can be gained by the following improvements.

Reporting in the booklets, in written form, was hard for some of the pupils. Quite often they only wrote a short answer down while the respondents told long stories full of personal details. Rich information is lost. Therefore, we advise to explore other ways of reporting or to conduct the interviews in pairs, with one pupil focusing on asking questions and the other on reporting and observing.

Most of the time, the questions the children asked were related to activities. It would be nice to elicit more storytelling during the interviews by follow-up questions instead of questions that lead summing up activities. Stories are a great way to develop empathy, are easily remembered due to the many details (Haven 2007). In this way, personas become richer and as they are easily remembered by the pupils, naturally used in the next stages of the design processes.

In our case-study, a researcher with a background in industrial design guided the process. Her role was crucial during the development of the research booklet, the interview training, the visualization of interview questions and she guided the exchange of interview results and other experiences as well as the development of personas.

However, for design and technology education we need methods that can be used by teachers can without outside supervision of an industrial designer. Research is also needed if teachers are able to guide the process in a similar way and the kind of professionalization they need. A complicating factor is that the researcher worked at times with a small group of four children, where as teachers will in general work with the complete class. This makes the facilitation more difficult.

In the project described here the subject of the interview was on the way elderly people want to move. The approach is however also applicable to different themes and does not have to be set beforehand. Specifying the subject themselves enables pupils to follow their own interest and curiosity during the research and design process.

Discussion

More and more, the dual nature of technology is acknowledged. In professional design and engineering, human centered design and the inclusion of user-research at the very start of a design process is of growing importance. This is also reflected in design and engineering education in higher educational institutions (Liem and Sanders 2013). This is not yet the case in primary and secondary education.

Human centered design approaches enable pupils to experience the different roles in design and engineering: social, artistic, entrepreneurial, abstract and practical work with materials (Bras-Klapwijk 2005; Klapwijk and Rommes 2009). When primary school pupils experience that technology is about users and used to solve important social problems such as the one present in our case study, we expect that a greater portion of them will become motivated for further studies in technology. An increased motivation is very welcome as many Western countries face a shortage of students that chose a career in engineering or in the natural sciences.

A focus on human centered design solves another problem as well. In general, primary school teachers have little experience with the 'hard' aspects of technology and do not feel confident to teach design and technology (Jarvis and Pell 2004; Murphy et al. 2007). The inclusion of 'soft' elements such as the user in design and technology education makes the subject less alien to primary school teachers. Some love storytelling and others find it relatively easy to guide pupils through the interview process. For most teachers the synthesis of the collected stories into a persona and the use of personas in the design process is however new and they will need some training or other professionalization opportunities.

We hope that policymakers and curriculum-developers will turn away from the object-centered Design and Technology education and explicitly state the necessity of human centered design. A statement is, however, not enough. Teachers need practical methods that can be employed in classrooms to include the user in the design process. Our method is one of the first methods in which children function as co-researchers in the fuzzy start of a design process and is applicable in primary as well as in secondary education.

As our project shows, cooperation between designers, who pursue goals from the professional design field and want to include children as co-researchers to develop better products, and educators, who pursue educational goals and want children to learn to design from a user-perspective, is beneficial for both fields.

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