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CREATIVITY IN CHILDREN'S DESIGN PROCESSES: IDENTIFYING INDICATORS OF DESIGN FIXATION

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ABSTRACT
This paper explores indicators of design fixation by following the development of the design ideas of a group of primary school children (age 10-12) carrying out a co-design project. Our goal is to find ways to improve the early mastering of DT (Diverging Thinking) and CT (Converging Thinking) skills, which in turn will help them to develop their creative abilities. The case study presented here indicates that the children showed adherence to the initial design idea and a lack of openness for divergent thinking at some points in the later stages of the design process, which led to little or no development of their design idea. Furthermore, we observed that the occurrence of design fixation in later stages of the design process has a negative influence on the creative development of the design idea. We grouped moments indicating design fixation into four categories that emerged from the data, which we named: "Band-aids", "Already taken care of", "Question not used for elaboration" and "It's not possible". We expect that these categories we found, which could be classified as indicators, will be helpful for a facilitator in identifying design fixation during the design process and adjusting the facilitation techniques accordingly. We expect these indicators to be present in sessions with students on different educational levels, which make these findings relevant to the education of future design professionals.

Keywords: Divergent thinking, Convergent thinking, Co-design, Ideation, Design Fixation.

1 INTRODUCTION

In the field of primary education there is a growing interest in the teaching and mastering of the, so called, 21st century skills. These are the skills that future generations need in order to master the challenges of a world growing in complexity and interdependence. These 21st century skills are closely related to many skills that children practice and learn while solving design problems. Creativity is one of these skills [1] [2] [3].

In this paper, we describe an explorative case study in which we observed the development of the design ideas of a group of primary school children (age 10-12) carrying out a design project. Our focus is on identifying key factors that hampered the development of their design ideas when these children applied DT and CT thinking processes. Descriptions of barriers and struggles of children's creative abilities during the design process are rarely published. We believe that acknowledging, researching and publishing these struggles will help researchers and educators to learn from each other's experiences in order to contribute to the development of creativity in design education. Our goal is to find ways to improve the early mastering of DT and CT skills, which in turn will help them develop their creative abilities.

2 RELATED WORK

Divergent (DT) and convergent thinking (CT) are important skills used throughout the whole design process. The ability to separate and alternate between the two is considered extremely valuable when developing creative solutions [4] [5]. 'Creative solutions' is often defined as both novel and relevant for the problem [6]. DT and CT, and especially the alternation between the two, are not only needed when generating the initial design ideas, but also to let the design ideas develop during the latter stages of the design process.

The development of design ideas through the repeated alternation of DT and CT is not always an easy process and can be easily stagnated by many factors, for example by the occurrence of 'design fixation'. Jansson and Smith [7] refer to design fixation as *"a blind, and sometimes counterproductive, adherence to a limited set of ideas in the design process"*. Purcell and Gero [8] also note the aspect of premature commitment to a particular problem solution: *"…the designer appears trapped by the characteristics of a possible solution that has been developed or an existing precedent solution"*. Design fixation can have negative effects on the design process. A designer can for instance become fixated on a certain type of idea that was generated at one point during the design process. When the designer is fixated on a certain type of idea, variations of the same idea are generated instead of a completely different idea. Fixation on initial ideas is an example of this [9]. However, to be able to design creative solutions, the generation of many divergent ideas is often needed. When a certain train of thought does not produce its intended goal, success depends on abandoning this train of thought and generating alternative ones [10]. Yet people are prone to think along the 'path-of-least-resistance' and therefore likely to form ideas from easily accessible pre-existing concepts from their memory [11]. Nicholl researched this phenomenon in secondary design and technology (D&T) students. In his research, it was acknowledged by students and teachers alike that generating original ideas is difficult for the students and that many of the generated design ideas are derived from popular culture or examples shown by the teacher, since this is an easily accessible source of inspiration for them [12][13]. As a result, many of the designs become stereotypical in nature. Nicholl suggest that design fixation is widespread among the work of secondary D&T students [14]. Next to the fixation on popular culture he also found that students got fixated on the first idea that came to mind and that they felt annoyed with having to think of multiple ideas. They did not understand the concept and possibility of acceptance and rejection of ideas and therefore just wanted to go with their first idea for which they already worked out on how to proceed. As one teacher stated in Nicholl's research: *"They get a fixed image, that's what I want to make. It's very hard to make them see that you can change and modify this. They're fixed, they think now that's what I want and that's what I'll do"* [14].

The majority of the research done on design fixation focuses on design students, secondary or up, or novice and experienced designers. Yet, we would argue that learning to detect and cope with design fixation on a young age appears relevant for the progress in design education. Identifying key factors that indicate the presence of design fixation in the children's design process is a first step towards possibly preventing or overcoming these types of obstacles. The research in this paper will focus on the occurrence of design fixation with children while they develop their chosen design idea, which will be referred to as the process of elaboration. Design fixation that occurs during the process of elaboration of the design idea is barely researched, since most design fixation research focuses on the initial stage of idea generation. Yet, also when developing and elaborating on a design idea, design fixation can still occur. Elaborating on a chosen idea remains a process of iteration and adjustment, which calls for an alternating process of DT and CT. In our research, we strive to identify these key factors that could indicate the presence of design fixation in the context of the design based research project *'Co-Design with Kids: Early mastering of 21st century skills'*. This paper describes the results of the first explorative case study within the research project. In this project, scientific partners and partners from education and industry develop a toolbox to conduct co-design sessions at primary schools. In the case study, as will be described in this paper, a first iteration of the toolbox, consisting of new and existing tools, is used. Insights from this study will be used for the next iteration of the toolbox so that the tools can be improved in an iterative manner.

3 STUDY

The study took place in one primary school class over a period of seven weeks in March/April 2016. Every week the children participated in a design session of 1,5 hours.

The class of 24 children was divided into six teams of four children by the teacher. Three researchers each facilitated two teams of children in separate sessions, except for the first and fourth and last session, in which the whole class participated at the same time. There was a problem owner who acted as a client towards the children. This problem owner visited the class 3 times; during sessions 1, 4 and 7. The design assignment the problem owner proposed was "design a game, lesson or sports equipment for the gymnasium of the future that enables children with different participation motives to be physically active together". During the weekly sessions, the children were led through different diverging and converging stages. The children were expected to take the assignment as a starting point and develop a new and relevant solution, within their team, by alternating between thinking of a lot of solutions and choosing between them.

4 ANALYSIS

The 7 sessions described above were audio and video recorded. Two teams of 4 children were selected for in-depth data analysis. This selection was based on observed differences in process and design outcomes of those two teams. Two researchers listened to all the recordings of these teams and transcribed discussions between the children, facilitators and problem owner. The same two researchers selected parts of the conversations from sessions 4, 5 and 7, in which it became apparent that the development of design ideas was hindered, and interpreted them with a grounded theory approach. In all the selected parts of conversations, the teams of four children had already selected an idea to elaborate upon.

5 RESULTS

Our focus is on the moment when the children have selected their initial design ideas and work on further developing and elaborating their ideas through the application of DT and CT processes. During data analysis, we found that the development of these ideas was hampered by different factors. One of the factors was design fixation. On several occasions during the design process the children exhibited fixation towards their initial design idea. This fixation was observed through the manner in which the children responded during conversations between teammates, other children, facilitators and problem owner. We grouped these responses that indicating design fixation into four categories that emerged from the data, which we named: "Band-aids", "Already taken care of", "Question not used for elaboration" and "It's not possible".

The following section introduces these four categories through a number of examples of conversations between children, facilitators and the problem-owner.

5.1 'Band-aids'

The first category is the use of, what we called, '*band-aids'. Band-aids* are additions or solutions that leave the core of the design idea intact and do not present a possible valuable and relevant development. They are 'quick fixes' used to 'patch up' any flaws. In addition, the DT process can be set to a halt during the use of *band-aids,* because the problem appears to be solved. When this happens the openness to keep generating alternative ideas is lost. As a consequence, it is difficult to restart a process of DT among the children.

The following example illustrates the use of *band-aids*. During the 5th session, one of the teams worked on the development of their chosen *maze-game* idea by, among other things, building a prototype. The facilitator opens the dialog by reminding the children of a requirement of the design challenge as set by the problem owner and continues by asking if this requirement has been met in the current state of their *maze-game* idea.

> *Facilitator: So Ivo (name problem owner) wants you to move a lot during the game. Do you think you will move a lot now?*
> *Facilitator: How can we make sure that they will move even more?*
> *Child 1: Multiple chasers (the players that are 'it' during a game of tag), but then you can also block someone. So two chasers.*
> *Child 2: And child 3 (teammate) and me can check if everyone is moving. That someone does not hide all the time or something. That we can judge if they move. So we just watch.*
> *Child 2: Or we say at the start that we will check who will move best and the one that did will get a present.*

Facilitator: But if this is used during physical education this means that you have to give presents during each class.

Child 1: That could be possible. The Action (discount store) has very nice things, really fun things for less than a euro.

Child 2: I will arrange the presents and a small treasure chest and glow in the dark stuff

(In the end, the presents are not arranged by any of the teammates)

The children show DT as they generate a number of options to ensure that all pupils will move during the maze-game, but there is a difference in the quality of options mentioned. The first idea mentioned by Child 1 focuses on changing the rules of the game. Yet the proposed 'judging' idea and 'give presents' idea by Child 2 do not transform the idea of the *maze-game* to intrinsically call for movement. They make use of external systems of judgement and rewards, which are options in the social area that compensate for possible problems in the game itself. Instead of continuing DT, the facilitator applies CT and reacts critically on the 'give presents' idea. As a reaction, the pupils explain how the 'present' idea can be realized. Exploring ways to make sure that pupils will move a lot during the Mae-game ends here.

5.2 'Already taken care of'

Another indicator of design fixation is the '*already taken-care-of' strategy*. This indicator was mostly detected during the 4th session, in which the teams chose their initial design idea and immediately received feedback form their peers and the problem owner. The conversation is about a device that combined a lot of sports in one object. On the spot, more sports were added to the design idea. We want to note that at this point in the process all the teams had chosen a rough first idea that did not yet contain much detail. The additions that the children mention in the conversation were not mentioned or discussed before within the team.

Child 1: What about if you want to do handball?

Child 2: You can do that as well with it.

Child 1: And if you like to play football?

Child 2: You can do that as well.

Child 3: So, it is all-in-one, and there is no korfball.

Child 2: Yes, there is korfball in there!

In a way, the conversation shows elaboration of the existing design idea by the adding of elements. However, Child 2 is also deflecting the questions by stating that everything already exists within the design. By using this strategy, the children do not use the feedback from others to check the quality of their design and to see if any further development is needed. Feedback appears to be something that needs to be contradicted and not something that they can learn from. As a result, the feedback that others give does not contribute to the further development of the idea.

5.3 'Question not relevant'

Another way some children parried feedback was by indicating that the question or suggestion was not relevant to their idea. In the first example below, a child suggests to think about playing the designed game together with other children. The other child answers that the game can also be played alone, leaving the first child a bit puzzled.

Child 1 (from another team): How can you do this game with friends?

Child 2 (from development team): Well. You don't have to do it with two people, you can also do it alone

Child 1: Okay…

In the following two examples the questions are answered by repeating the answer.

Child: And then they have won.

Fac.: Ok, and what happened when they win? How does that affect the game?

Child: Well, they just win.

Child: And then the teams are divided.

Fac.: How are the teams divided? So you push the button, and then what happens?

Child: the teams are just divided…

By immediately judging the raised question as not relevant the children miss a possible opportunity to elaborate their design idea. In the last two examples, the facilitator tries to start a process of elaboration by asking questions about a certain detail of the idea. Yet, the children do not appear to see

the need to think about these kinds of details. Because of this, the questions raised are not being properly evaluated by the children and therefore not used to further elaborate and develop their idea.

5.4 'It's not possible'

The following example illustrates how critical thinking hampers DT and elaboration. In the dialog the children repeatedly use the *it's-not-possible* reaction. Whatever is being proposed is not properly evaluated, immediately seen as not feasible and therefore dismissed. In a situation like this, the children could miss many opportunities because they are in a mind-set that is not open to any feedback.

Child 1: That's impossible, the lights go on when you enter the gym.
Facilitator: Well, I'm sure we could turn off the lights.
Child 1: It is still too light because of the window.
Facilitator: We could cover the windows.
Child 2: Than it is too dark, children won't be able to see, that is dangerous.

6 DISCUSSION / CONCLUSION

The explorative case study presented here indicates that the children showed adherence to the initial design idea and lack of openness for divergent thinking at some points in the later stages of the design process, which led to little or no development of their design idea. The study indicates that the occurrence of design fixation in later stages of the design process has a negative influence on the creative development of the design idea. Analyzing the categories, led us to understand that all of them entail the 'art' of receiving feedback, which is a complex and difficult skill. We theorize that to prevent and/or overcome design fixation the children need to develop the ability to evaluate their own idea through own observations on feedback and questions of others. Accordingly, they need to be able to evaluate if the feedback is relevant or not. When evaluated as not relevant, the children should be able to formulate reasons why they take this position. The results show that this skill of critically evaluating one's own design idea still needs improvement. Simultaneously, the facilitators also need better guidelines and techniques that promote openness with the children to further elaborate on their idea. The facilitators used different techniques to get the children to elaborate and develop their design ideas, for example: asking questions, raising possible problems and giving suggestions. Even though the techniques were intended to provoke a DT process, they in some occasions evoked the opposite.

Based on these findings we are currently revising the toolbox and adjusting it for the use in future case studies within the research project. We will, firstly, focus our efforts on teaching the children how to critically evaluate their own design process and how to use the feedback of others. This also entails the difficult process of letting go of ideas. Youmans and Arciszewski did a literature review on design fixation and proposed three fixation categories: Unconscious Adherence, Conscious Blocking and Intentional Resistance [15]. As of now we are unsure in which of the categories the design fixation shown by the children could be classified, we plan on exploring this in further research.

Knowing if the fixation is unconscious, conscious or intentional influences the type of tools and facilitation needed to prevent or overcome the fixation. Secondly, we are formulating guidelines and practical advice for facilitators. For example, discussing with the children why certain questions are asked by the facilitator might help the children to understand the facilitation strategy and make them more willing to use this feedback.

When design fixation does take place during a design process, we expect that the indicators we found - 'band-aids', 'already taken care of', 'question not relevant' and 'it's not possible' – will be helpful for a facilitator in identifying design fixation and later on adjusting the facilitation techniques accordingly. This aligns with suggestions from the research of Nicholl and McLellan who also believe that targeted intervention from the person facilitating is needed to prevent and/or overcome design fixation[14]. We expect these indicators to be present in sessions with students on different educational levels, which makes these findings relevant to the education of future design professionals. By identifying design fixation during the design process, we will be a step closer to being able to help novice designers on how to deal with this fixation.

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