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Children's Responses to Divergent and Convergent Design Feedback

Alice Schut, Delft University of Technology, The Netherlands

Remke Klapwijk, Delft University of Technology, The Netherlands

Mathieu Gielen, Delft University of Technology, The Netherlands

Marc de Vries, Delft University of Technology, The Netherlands

Abstract

In this paper, we explore the divergent and convergent nature of design feedback and the various responses to this feedback from a group of 24 young novice designers (primary school children age 9-11) taking part in a co-design project. Earlier research emphasizes that feedback can encourage a designer to take divergent as well as convergent paths during their design process (Cardoso, Eris, Badke-schaub, & Aurisicchio, 2014; Yilmaz & Daly, 2014, 2016). Yet our previous research shows, that feedback given to primary school children while designing does not always spark creative thinking (Schut, Klapwijk, Gielen, Van Doorn, & De Vries, 2019). We presume that the responses we found might have been influenced by the type of feedback that preceded them. Therefore, we have elaborated on the results we've previously uncovered with an additional analysis of the same case study. This additional analysis shows that divergent feedback given by peers or a client will not necessarily promote divergent thinking processes, whereas convergent feedback will not necessarily promote convergent thinking. Furthermore, responses indicating resistance towards the feedback given were widespread. However, we believe that feedback from clients and peers can still be a fruitful strategy in learning to be creative and in promoting divergent thinking (DT) and convergent thinking (CT) and end with suggestions on how this might be achieved.

Keywords

design feedback, design fixation, convergent thinking, divergent thinking, creativity, D&T education

Introduction

In recent years, creativity is progressively seen as a skill of great value within the context of primary education. Design and technology-related subjects offer great opportunities for children to develop their creative abilities (Lewis, 2005, 2009; Rutland & Barlex, 2008; Thijs, Fisser, & Hoeven van der, 2014; Voogt & Roblin, 2012) and more and more focus is put on the importance of this provision in Design and Technology (Atkinson, 2000; Benson &

Lawson, 2017; Benson & Lunt, 2011; Klapwijk & Holla, 2018; Lewis, 2005). When designing, children are confronted with ill-structured problems, which are open ended in nature and solutions are not defined in advance (Dorst, 2003; Lewis, 2005). This means that no one 'right' answer exists and they therefore need to resort to creative thought processes to generate and develop solutions (Lewis, 2009).

Yet behaving creatively does not always come naturally to children. For example, it is known that the occurrence of design fixation – a sort of block in creative thinking processes – can hamper the generation and development of creative solutions by driving the children to think along the path-of-least resistance and leaving them fixated on certain aspects of their design (Luo, 2015; McLellan & Nicholl, 2009; Nicholl & Mclellan, 2007; Schut et al., 2019). It appears that there is a need to help the children identify and understand the obstacles in their creative thinking and help them move forward in their creative process.

It is commonly thought that receiving design feedback from others is one of the factors that can benefit the creative design process greatly (Crilly 2015). Design feedback can help guide the creative thinking processes - divergent and convergent thinking - that are present in a design process. Design feedback can push towards convergence by suggesting evaluation, reflection and decision making. It can also push towards divergence by suggesting the exploration of alternatives. Yet, one may ask if the divergent or convergent nature of the feedback always elicits the expected responses and therefore push towards the intended direction in one's creative process. Design feedback is expected to teach novice learners insight in their creative processes and design decisions, yet it can also uncover or evoke resistance (Cardella, Buzzanell, Cummings, Tolbert, & Zoltowiski, 2014; Cardoso et al., 2014; Cummings, Tolbert, Zoltowiski, Cardella, & Buzzanell, 2015; Schut et al., 2019).

Our previous study shows that feedback that is given to primary school children while designing does not always spark creative thinking (Schut et al., 2019). In this article, we will therefore look at the same case study in order analyse feedback conversations that take place between the children who are designing, their peers, and the client during the later stages of their design processes. Our goal is to identify the divergent and convergent nature of the design feedback present in the critiquing moments and the various responses of the children to this feedback. This is translated into the following explorative research question: What is the nature of the design feedback that is given by client and classmates and how do the design teams respond to these different types of feedback? We are especially interested in the moments in which the children show resistance to design feedback and hope to uncover how this might relate to the divergent or convergent nature of the feedback.

Divergent and convergent thinking

Designing is an inherently creative activity (Goldschmidt, 2014; Howard, Culley, & Dekoninck, 2008). It requires complex cognitive processes through which a designer explores the problem and solution space (Dorst & Cross, 2001). Two creative thinking processes herein play a central role: divergent thinking (DT) and convergent thinking (CT) (Finke, Ward, & Smith, 1992; Goldschmidt, 2014, 2016; Guilford, 1956, 1962). DT entails the generation of novelty, which is commonly thought to go hand in hand with the ability to see lots of possible answers and interpretations to a problem or issue. CT entails the evaluation

and exploration of this novelty, which deals with developing, analysing and selecting the 'best' answer to a problem or issue. Though the continuous alteration between DT and CT creative solutions get generated and developed (Guilford, 1967; Howard-Jones, 2002; Isaksen, Dorval, & Treffinger, 2010; Isaksen & Treffinger, 2004; Mioduser & Kipperman, 2002; Tassoul, 2009).

Yet understanding how and when to best shift between these cycles of thought is not easy, especially for novice designers. Many factors can hamper these creative thought processes. For example, the occurrence of design fixation, known as the blind adherence to a limited set of ideas or problem solution (Jansson & Smith, 1991; Purcell & Gero, 1996), is a known obstacle in young novice learners' design processes (Luo, 2015; Mclellan & Nicholl, 2013; Nicholl & Mclellan, 2007; Schut et al., 2019). Within design education, guidance in navigating this shifting and alternating process is therefore needed. Although this guidance can take different forms, like structured courses, tools and methods, assessment guidelines and coaching (Dannels, Gaffney, & Martin, 2008; McLellan & Nicholl, 2009; Nicholl, 2004; Nicholl & Mclellan, 2007; Tolbert & Daly, 2013), this article focuses on the role of design feedback.

Design feedback

Although little is known in relation to young novice learners in the design setting, feedback interventions are common educational practice in design disciplines at university level to discuss the progress and status of a student's design projects (Dannels, 2005; Oh, Ishizaki, Gross, & Yi-Luen Do, 2013). Usually, there are several feedback interventions integrated in the design process at different stages. In those moments, students get the opportunity to update their instructors, their peers and other stakeholders, such as real or simulated clients and potential users, on their envisioned design and collect feedback. Oh et al. (2013) describe how these conversations are the predominant way through which students acquire expertise from their instructors and other stakeholders. Additionally, it adds the aspect of socializing students into the discipline, which prepares them for the 'real world' (Cummings et al., 2015; Dannels, 2005; Oak, 2000; Oh et al., 2013).

Commonly these interventions are known as 'design reviews' or 'design crits'. Although there are many similarities, and the terms are often used interchangeably, in this paper the focus will specifically be on design crits. Design critiquing is about improvement. This is attained by discussing how well the design addresses the goals and principles that were set beforehand. Within these discussions is not necessarily about getting everyone's approval, like design reviews tend to be (Sater-Black & Iversen, 1994), but about giving options and opinions on how to move forward within the design process. The active conversations can trigger students to reflect on, evaluate and revise their designs (Oh et al., 2013), therefore impacting on divergent or convergent paths they may take in their creative process.

Divergent and convergent design feedback

Design feedback can steer creative thinking processes in divergent or convergent directions. Although feedback can potentially benefit the creative design process (Crilly, 2015), literature shows that it can also evoke less than optimal reactions in novice designers.

For example, Cardella et al. (2014) and Cummings et al. (2015) investigated the different directions design feedback can push towards and linked it to the processes of creating and reducing ambiguity between instructors and university students. They found that instructors who only work on eliminating ambiguity by giving feedback that pushes towards convergent actions through clarification, can provoke students to become defensive and try even harder to convince everyone of the quality of their design (Cardella et al., 2014; Cummings et al., 2015). These types of interactions could inhibit a student's creative thinking, since they will not easily engage in reflective or evaluative thinking about the state of their idea when they feel they have to justify it.

This focus on clarification through convergent feedback by instructors was also observed by others (Cardoso et al., 2014; Daly & Yilmaz, 2015; Yilmaz & Daly, 2014, 2016). In a study on question asking during design reviews, Cardoso et al. (2014) observed that due to this focus by the instructor, the students end up being too descriptive and do not engage in any reflective and evaluative thinking about the design decisions made. Yilmaz and Daly (2014, 2015, 2016) also observed this focus on clarification and decision making and found that instructors from different disciplines all primarily engage in convergent feedback. They note that although this type of convergence is necessary in working towards a design result, it should not be prioritized over the exploration of 'better' solutions or the pursuit of risky ideas. More balance between both types of feedback is therefore encouraged by the authors and the need for divergent feedback is brought forward (Daly & Yilmaz, 2015; Yilmaz & Daly, 2014, 2016).

From these studies, it appears that the primarily convergent design feedback from the instructors is not always met with the expected reactions from the students and does not necessarily facilitate DT or CT. Similarly, our previous study shows that feedback that is given to primary school children while designing does not always spark creative thinking (Schut et al., 2019). Instead, it was found that the children often rejected or ignored the feedback in order to leave the core characteristics of their design ideas intact and unchanged. This fixation on their idea was observed through four uncovered types of response behaviours: 'band-aids', 'already in there', 'question not relevant' and 'it's not possible' (Schut et al., 2019). Since unwanted reactions to feedback have been observed with university students, it is possible that responses of the children have been influenced by the preceding feedback. It could therefore be worthwhile to explore the nature of the feedback preceding these uncovered response behaviours.

A design feedback model

One of the ways in which the nature of design feedback can be uncovered is through the use of Eris' question driven design model (Eris, 2004). Eris perceives design as a question driven process. He therefore created a model that encompasses the types of divergent and convergent questions asked when designing in teams, which is made visible in Figure 1. Use of this model has, for example, provided insight into the types of questions that can spark creative thinking within design processes (Cardoso, Badke-Schaub, & Eris, 2016).

Although the model is intended to analyse the question behaviour of a design team while designing (Cardoso, Badke-Schaub, & Eris, 2016; Eris, 2004), it has also been used to analyse the feedback present in design crits (Cardoso, Eris, Badke-schaub, & Aurisicchio, 2014). It would therefore be interesting to explore the nature of the design feedback present in our case with primary school children and insight this can give in relation to creative thinking.

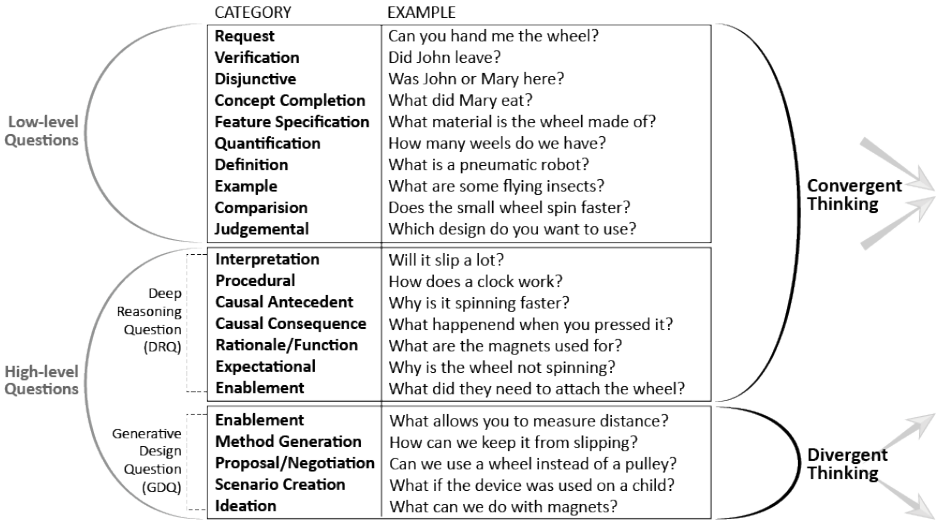

Figure 1. Eris' Question Driven Design Model (Eris, 2004)

Research Design

Participants

The design sessions took place at a primary school in the Netherlands in the area of Zuid-Holland. The selection was based on the school's interest in design and technology education and a wish to experience a guided hands-on design project. The participating school is 'development-focused', meaning that umbrella themes are used to integrate different learning subjects. In this study, one class participated over a period of seven weeks in March and April 2016. The class consisted of 24 children, ranging between 9 and 11 years old. The class was divided into six gender-mixed heterogeneous design teams of four children by the teacher. Although the children had no experience with designing, the

teacher stated that the children were used to giving feedback to each other during other subjects in the classroom.

Design problem

The children worked on solving a real-life open-ended design problem. This was made available by the HALO sports academy, which is part of The Hague University of Applied Sciences in the Netherlands. The assignment: “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.” An example of different ‘participation motives’ is a child who enjoys a competitive component during physical activities and plays to win versus a child who enjoys playing together, regardless of winning or losing the game. An experienced teacher from the HALO acted as a client for the children. He introduced the design assignment and was present during several of the design sessions to give feedback on the children’s design ideas. He had no specific experience in addressing or teaching primary school children.

Design sessions

Over the course of seven weeks the design teams took part in weekly design sessions of 90 to 120 minutes. In Table 1 an overview of the design sessions and their connection to the design cycle (Figure 2.) known by Dutch primary school teachers and pupils is presented. The design activities were based on tools and methods from the CPS tradition (Isaksen et al., 2010; Tassoul, 2009) and design tools from the Delft Design Guide (van Boeijen, Daalhuizen, Zijlstra and van der Schoor 2013). These methods and tools were transformed for use at primary school level in collaboration with the Science Hub Delft (Wetenschapsknooppunt Zuid-Holland n.d.), which is an organization who develops and researches educational design material for primary schools.

Facilitation

Three facilitators were present during the design sessions to facilitate the teams. Each facilitator was assigned two teams. Two facilitators, the first and second author, had a double role as researchers within the project.

Setting

During the design sessions 2, 3 and 5, the teams were facilitated by their assigned facilitator in separate rooms. Session 1, 4, 6 and 7 took place in a classroom setting during which all teams took part simultaneously.

Table 1. Overview of the design sessions - Session 4 and 7 were selected for in-depth data analysis

Session	Facilitation	Design phase	Activities
1	Classroom facilitation	Exploring & Formulating design problem	- Introduction of the design assignment by the client. - Experiencing different sport preferences and participation motives within the class through group activities led by the client. - Timeline visualization of positive and negative physical education experiences. - Brainstorm to shed first ideas.
2	Separate team facilitation	Exploring & Formulating design problem	- Constructing interview questions. - Practice interview. - Homework: do interviews with other children.
3	Separate team facilitation	Generating & Selecting ideas	- Discussing the interviews. - 3 brainstorm techniques. - Categorization of all ideas. - Idea selection. - Top 4 selection.
4	Classroom facilitation	Generating & Selecting concepts	- Make a small model/first prototype of two ideas. - Feedback on ideas from the client and classmates (1st critiquing moment) - Selection of one idea.
5	Separate team facilitation	Building a prototype	- Make a building plan. - Build a prototype with provided materials. - Make a testing plan.
6	Classroom facilitation	Testing & Optimizing	- Build-up for the test. - Test with other children. - Get feedback from testers. - Think of implications for design.
7	Classroom facilitation	Presenting	- Feedback on designs from the client and classmates (2nd critiquing moment)

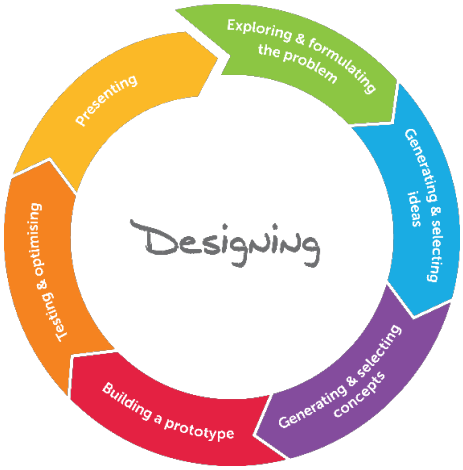

Figure 2. The Design Cycle (Klapwijk & Holla, 2018)

Critiquing moments

During the 4th and 7th sessions the design teams received feedback from their classmates and the client on the state of their design ideas through two design crits. For both critiquing moments the client and children received no specific instruction from the facilitators on how to give feedback. It was expected that the teams would use the feedback that was given to improve their design idea by adjusting and elaborating on its current state. This expectation was communicated to the teams by the client through a short presentation at the start of design session. In this presentation the importance of feedback in relation to idea development was pointed out through the phrase: "Feedback = OK!" and several examples. Additionally, the client pointed out that although sometimes you might feel hurt or attacked by the feedback that is given, it is always meant to help.

The first critiquing moment took place during the 4th design session. At that moment in the design process all design teams had selected one or two initial ideas and constructed corresponding small 'quick and dirty' models. Through turn taking each design team had the opportunity to present their design idea, illustrated with the models. After presenting their design idea each team received feedback from the client, as well as from the other design teams (their peers).

The second critiquing moment took place during the 7th design session. All design teams had prepared a short presentation in which they illustrated their final design with drawings or photos of their prototypes. Again, the design teams received feedback from the client and the other design teams (their peers). Since this was the final design session, the focus was not so much on possible future improvements, but more on revealing the final state of the design. This expectation was also communicated to the children by the client.

Data collection and analysis

The seven design sessions were audio and video recorded and the materials that the children produced during the sessions were photographed.

Segments and pairs

To examine which type of feedback and responses occurred together, the feedback and concurrent responses were grouped before coding. Segments were created of consecutive feedback and responses based on the feedback content. Within these segments pairs of feedback and response were formed. When multiple questions and comments were posed in a row, or when multiple answers were given in a row, these would be grouped to form one pair consisting of multiple feedback and response codes. All pairs were coded with the corresponding feedback type codes and response type codes. Additionally, we coded who posed the feedback to the design teams i.e. the client or peers. The qualitative analysis software Atlas.ti was used during the entire analysis process.

Feedback types

To determine the nature of the feedback, Eris's question-driven design model (see Figure 1) was used as our primary lens to analyse the feedback posed by the client and peers (Eris, 2004). The model makes a distinction between two levels of questions: Low-level Questions and High-level Questions. The High-level Questions are divided into Deep Reasoning Questions (DRQs) and Generative Design Questions (GDQs). Low-level questions are mainly information seeking questions and are posed when a questioner for example wants clarification or verification about certain aspects of the design. High-level questions ask for a higher level of reasoning and often entail reflection, evaluation and/or generation. In the model, Low-level Questions and DRQs are classified as convergent. These types of questions are presumed to facilitate convergent thinking processes and share the common premise that a specific answer, or a specific set of answers, exists. GDQs are classified as divergent, since they are presumed to facilitate divergent thinking processes by proposing alternative answers and prompting their generation.

The first author initially coded all the transcribed data, after which consensus and consistency were promoted by routinely discussing the coded data with the second author. Since we were not solely interested in questions, not all instances of feedback could be coded with Eris' model. These particular segments of feedback were therefore coded inductively, which resulted in three new codes: 'Critique', 'Compliment' and 'Direct recommendation'. For the purpose of this study, we added these three codes to Eris' model and classified them as Low-level Comments and part of the convergent category. This adapted model is visualized in figure 3.

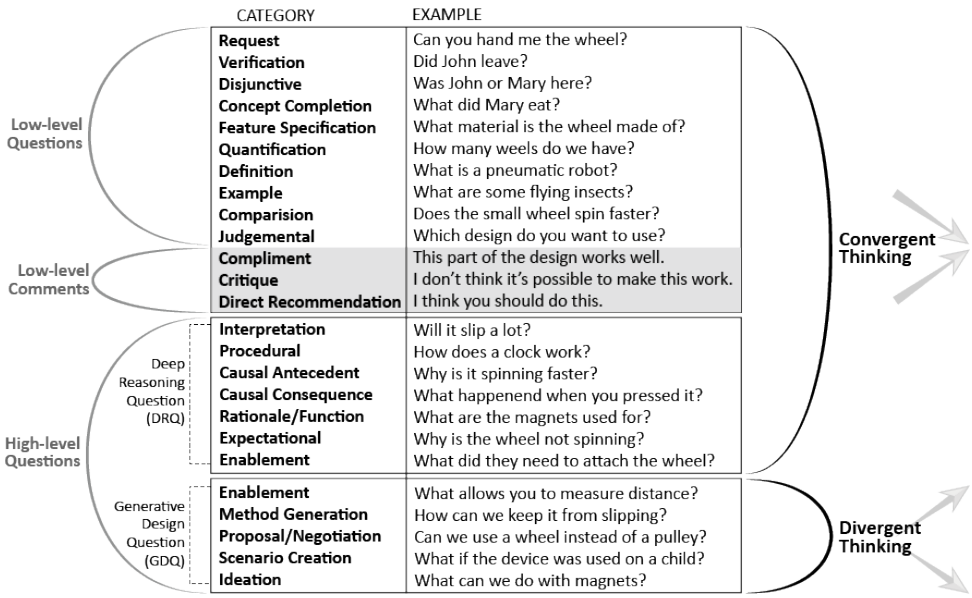

Figure 3. Adapted version of Eris' Question Driven Design Model.

Types of responses

To determine the different types of responses of the design teams, all responses were labelled through open-coding, allowing codes to emerge from the data itself. Four of these response types were previously identified in this particular dataset through open coding, namely 'band-aids', 'already in there', 'question not relevant' and 'it's not possible' (Schut et al., 2019). Afterwards we refined these codes by comparing them to a framework of student response codes created by Cardella et al. (2014) and Cummings et al. (2015). Due to the different context of their studies the conscious decision was made to not use their framework inductively. When comparing the codes uncovered through open coding to the framework of Cardella et al. (2014) and Cummings et al. (2015) we found that several codes overlapped, some could be adopted and a few could be dismissed due to irrelevance to our context. Overlapping codes were merged and the code name from the source that described the response type in most detail was adopted. From this process an improved framework for responses to design feedback in primary design projects emerged, which is made visible in Table 2. Again, the first author initially coded all of the transcribed data, after which consensus and consistency were promoted by routinely discussing the coded data with the second author.

Table 2. Children's responses to design feedback

Code	Description of the behaviour	Source
Band-aids	Adjustments or elaborations to the design idea that do not present a valuable and relevant development and	Open coding, published in Schut et al. (2019)

	leave the flawed core of the design idea intact and unchanged.	
Already in there	Uncovered shortcomings and missing elements within the design idea are dismissed by stating that they have been present within the idea all along when this is not the case.	Open coding, published in Schut et al. (2019)
Question not relevant	Feedback is indicated as not relevant to the design idea.	Open coding, published in Schut et al. (2019)
It's not possible	Proposed adjustments or elaborations are deemed as not feasible without proper evaluation.	Open coding, published in Schut et al. (2019)
Ideation	Coming up with new ideas/exploring new possibilities	Open coding
Confirming	Confirming that what someone states/assumes is correct	Open coding
Insecure	Reaction indicating insecurity about what to answer	Open coding
Show	Physically showing something (part of design/drawing/etc)	Open coding
Ask	Clarifying questions	Cardella et al. (2014) / Cummings et al. (2015)
Restate	Student restates the information from the person providing the feedback	Cardella et al. (2014) / Cummings et al. (2015)
Acknowledge	Indication of active listening	Cardella et al. (2014) / Cummings et al. (2015)
Agree	"Ok", "I will do that"	Cardella et al. (2014) / Cummings et al. (2015)
Report	Explaining a feature or the design	Cardella et al. (2014) / Cummings et al. (2015)
Silence (non-verbal)	No reaction present	Cardella et al. (2014) / Cummings et al. (2015)
Nodding (non-verbal)	Physical response to any type of feedback	Cardella et al. (2014) / Cummings et al. (2015)

Results

The following sections introduce the occurrence of the different types of feedback and responses throughout both critiquing moments. Specifically, we concentrate our efforts towards discussing the responses that indicate a form of resistance towards design feedback and expose their relationship to the nature of the feedback types and additional feedback properties.

Types of feedback

Figure 3 gives an overview of the occurrence of the different types of feedback during the first and second critiquing moment. In both critiquing moments convergent as well as divergent feedback is posed by the client as well as the peers. Overall, the first critiquing moment contained more instances of feedback than in the second. In this first critiquing moment the client posed more feedback than the peers, especially low-level questions, comments and GDQs. In the second critiquing moment the peers posed more feedback than the client. What is remarkable is the relatively high amount of DRQs asked by the peers during this critiquing moment.

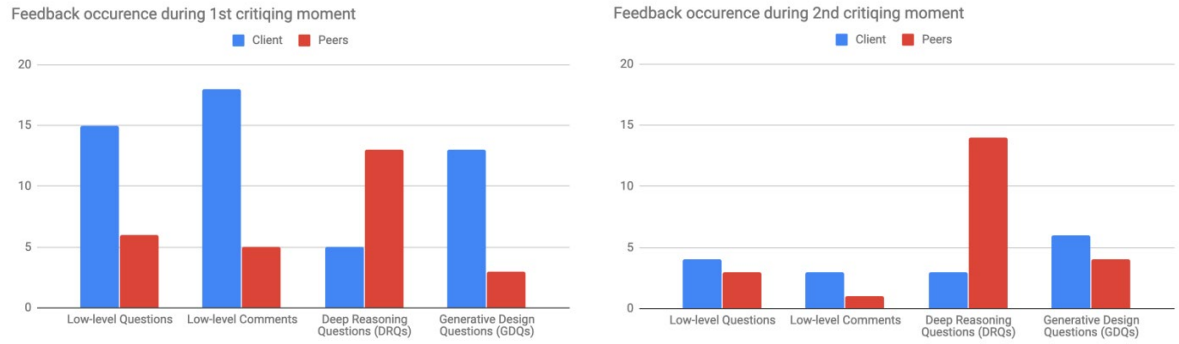

Figure 4. Occurrence of the different types of feedback posed by client and peers during the 1st and 2nd critiquing moments.

Convergent feedback

Overall *convergent* feedback was most prominent during both critiquing moments. When looking closer at the different types of *convergent* feedback, we see that the client mostly engaged in low-level questions and comments, while the peers took a leading role in posing Deep Reasoning Questions (DRQs).

Low-level questions were generally posed by the client to clarify or verify certain aspects of the design idea. For example:

> *Client: What are the game rules?*
>
> *Client: Ok, so if I understand correctly there is a video game attached to it?*
>
> *Client: So, you are moving in the game and on the screen?*

Since the client took a leading role in both critiquing moments and was generally the first to provide feedback to the design teams, this could explain why most low-level questions were posed by the client. The low-level comments that were posed by the client mainly consisted of compliments. Often these compliments were interwoven with other types of feedback. For example:

> *Client: You did choose a really nice topic. Something that everybody will find cool. And that was also sort of my assignment right, creating something that everybody will find cool. [compliment (low-level comment)] Yet, what is really new about it? [Causal Antecedent (DRQ)] What makes this different? [Rational (DRQ)]*
>
> *Client: I think it's really cool! [compliment (low-level comment)] I envision the gym of the future maybe without all that equipment [proposal (GDQ)]. That there is nothing in the gym, only those beamers and a really cool game that we can project. [ideation (GDQ)]*

In both examples the client starts with a compliment, after which he directly continues with expressing a concern or posing a suggestion.

Even though the peers also posed a few low-level questions and comments, the great majority of their feedback consisted of DRQs. More than half of all feedback that was given by the peers consisted of this type of feedback. The high-level questions they posed were concerned with how the design came to be, how it exactly works and why it works that way. For example:

> *Peer: Well, how can you for example climb that tree?*
>
> *Peer: Most of the equipment is not very high, so how can you then hide well?*
>
> *Peer: I don't think a player is able to slide on their knees the entire time. Right?*

In the DRQs above, several concerns are expressed about the designs. By posing these questions the peers ask the design teams to reflect and evaluate their design.

Divergent feedback

Divergent feedback, in the form of Generative Design Questions (GDQs), was present in both critiquing moments. Yet a clear spike in its occurrence was observed in the first critiquing moment, caused by the client. Through divergent feedback he appeared to persuade the design teams to explore alternative features or possible new additions to the design. For example:

> *Client: I am searching for a way to customize it for different players. How could we do that?*
>
> *Client: So maybe, when using a camera, you [a player] could think 'well, I'm not someone that is able to run fast, so I stay far from the catcher'. And someone who is very good (in running fast), they maybe need something to provoke the catcher a bit?*

Types of responses

The type of responses that followed the different instances of feedback varied throughout the critiquing moments. The occurrence of many of the responses appears incidental, making it difficult to discover distinct patterns. However, there was a group of responses that took a prominent position in both critiquing moments. Together, the 'band-aids', 'already in there', 'question not relevant' and 'it's not possible' made up about half of the responses in both critiquing moments. Through these responses the design teams showed resistance towards the design feedback posed to them. In the next section we present the observed feedback and an overarching pattern preceding these four types of responses. From now on we will refer to these four types of responses as 'resistance responses'.

Feedback preceding the four resistance response behaviours

Convergent feedback

The resistance responses were predominantly preceded by convergent feedback, especially by DRQs posed by classmates. Through these DRQs the classmates often revealed to the design team how they expected certain mechanisms in the design idea to function incorrectly. The following 'no handball included' example illustrates this. In all examples 'designer' plus a number refers to members of a design team.

> **No handball included**
>
> *Peer: If you for example throw a ball during handball,*
>
> *then the computer can never know how fast you throw. Because he can also not…*
>
> *Designer1: But we don't offer handball.*
>
> *Peer: Okay. Then soccer, if you then kick the ball then you don't know how fast you will kick?*
>
> *Client: Well, the computer would be able to measures that. You can make that happen.*
>
> *Designer2: Yes, there are machines that can measure how fast it goes.*

Here the expectation of the classmate is that the computer will never be able to measure the speed of a ball thrown within the game. First the design team tries to parry the question by focussing on the sport used in the example, which they state is not part of their idea. This behaviour enables the team to ignore the question and show that their idea still 'works'. The peer then repeats the expectation, prompting the client to step in and contradict the expectation of the classmate. This help is quickly embraced by the team. DRQs generally ask for reflection and evaluation of the design idea, which can ultimately help to develop and improve it. Yet this behaviour was not observed here. The first reaction of the team to feedback of the peer was to parry it, showing little intention to evaluate the feedback and possibly using it to improve their idea. This behaviour could have been promoted by the peer sharing expectations about the idea without any explanation towards the team as to what these assumptions are based on. A second example showcases another instance in

which a peer poses a DRQ, yet does not communicate the expectations and assumptions about the design idea clearly and directly.

No friends needed

Peer: How can you do this game with friends?

Designer: Well. You don't have to do it with two people, you can also do it alone

Peer: Okay…

The peer's question stems from the design question given by the client, which focusses on children being active together. One of the children from the design team answered that the game can be played alone, implying that no other players are needed. This left the peer a bit puzzled. Here, the peer expects the design idea to not fulfil a certain wish of the client, namely: stimulating playing together. Yet this expectation is not communicated directly by referring back to the design problem and the unfulfilled design criterion. Again, the first reaction of the design team is to parry the question, instead of taking it as an opportunity to reflect and evaluate.

Divergent feedback

There were also instances in which the four resistance responses were preceded by *divergent* feedback in the form of GDQs, which were mainly posed by the client. In those cases, the client often proposed multiple new alternatives for certain features or completely new additions to the design idea. The following example from the dialogue showcases how one of the design teams reacts to the *divergent* feedback from the client.

New proposals

Client: What might be nice is something you can see in some playgrounds.

That you get points if you hit something. You know?

Designer: Yes, this game is that you can shoot and then you get points.

Client: Yes. And that could be from two sides this way. Right?

Maybe the computer can control and move this, or that you move it yourself.

Designer: If you stand there the sticks will fall and then you can get them really fast.

Client: Yes, nice. Or maybe this goal can turn around and

that you think of a game in which the goal moves around all the time.

That will keep making the game more difficult.

Designer: [silence...] Maybe… [end conversation]

The client starts with proposing a new addition to the game. The design team reacts by stating that his proposed addition is already present in the idea. The client then continues with a stream of several new additions, showcasing different directions in which his proposal could be manifested in the game. The dialogue then ends with the team showing little enthusiasm towards the proposed additions of the client.

Although the feedback of the client can be classified as *divergent*, it does not appear to spark any new DT processes with the design team. This could be due to the stream of additions the client proposes, which he thinks will make their idea better, without checking with the team how they view these additions in relation to their idea. All the proposed additions appear to stem from the client's expectation that the game needs to get more difficult over time, but this is not mentioned explicitly. Furthermore, the client assumes that the current state of the design idea does not yet fulfil this assumption. Yet this is not communicated clearly, therefore keeping the team in the dark about the client's true intentions for the majority of the dialogue. Although other reasons may exist, this lack in transparency may have caused the design team to be less open to the new additions.

Discussion

Divergent & convergent design feedback

Our results show that with no guidance on how to give design feedback, the client and peers both pose divergent as well as convergent feedback to the design teams. Yet overall, convergent feedback was considerately more prominent in both critiquing moments. This result has similarities with previous studies that also found convergent feedback to occur more frequently (Cardella et al., 2014; Cardoso et al., 2014; Cummings et al., 2015; Yilmaz & Daly, 2014, 2016). We observed that the client posed the majority of convergent feedback through low-level comments and questions, concerned mainly with clarifying the designs of the teams. This focus on clarification by the client has similarities to previous studies, where instructors were observed to also have this tendency (Cardella et al., 2014; Cardoso et al., 2014; Cummings et al., 2015).

Although few instances of high-level convergent feedback were found with the client, more than half of the feedback posed by the peers consisted of high-level convergent DRQs. By posing these questions the peers ask the design teams to reflect and evaluate their past, present and future design decisions. This is quite remarkable and suggest that more research on this phenomenon is needed. One explanation could be that because they were participating in the same design sessions as the design teams presenting, certain design choices made by the teams were more striking to the peers than to the client. Additionally, the teacher noted that the children were used to giving feedback during other subjects, although we have no information on the nature of this feedback. Next to this, we speculate that the client might not have known how to pose these types of reflective and evaluative questions to that age group, therefore abstaining from it. Cardoso et al. (2014) found the instructor in their study to also abstain from DRQs in a university context, which could point to a more general difficulty in posing these types of questions.

Even though overall convergent feedback was more prominent, divergent feedback was also present in both critiquing moments. The client was the one primarily engaging in divergent feedback in the form of GDQs. Additionally, there was a spike of divergent feedback during the first critiquing moment. We speculate that this could be due to the unfinished state of the design ideas during the first critiquing moment and assume that the client tried to encourage the teams in developing their ideas by posing GDQs.

Reactions to the design feedback

The results on the occurrence of the different type of responses showcase how the convergent or divergent nature of the feedback does not necessary guarantee the start of the corresponding thinking processes within the design teams. Around half of all responses consisted of one of the four resistance responses, which stagnated the divergent and convergent thinking processes of the design teams. In those instances, the convergent feedback, especially DRQs, did not lead the design teams to reflect or evaluate their design. Instead the design teams appeared to become defensive and tried to prove the quality of their design, which is similar to results found by others in the context of higher education (Cardella et al., 2014; Cardoso et al., 2014; Cummings et al., 2015). Additionally, the occurrence of resistance responses also pointed out how divergent feedback did not always spark new ideation processes. It appears that convergent or divergent feedback alone is not enough to guarantee the start of new divergent or convergent processes with the children.

Possible contributing factors

The resistance the design teams exhibited to the design feedback given by the client and peers hampered their creative thinking processes. We believe there are several factors that could have contributed to this high occurrence of resistance responses by the teams. Firstly, we speculate that the high occurrence of convergent feedback may have limited the initiation of creative thinking processes within the design teams. High occurrence of convergent feedback is thought to hamper exploratory thinking and risk taking, which are both essential within creative processes (Tolbert & Daly, 2013; Yilmaz & Daly, 2016). Although convergent thinking is essential in working towards a final design, more balance between divergent and convergent feedback could prove promising in creating better and more creative designs.

Coupled with this, we expect that (implicit) expectations and assumptions about the design ideas, that we found present within the convergent and divergent feedback, hindered the initiation of both DT and CT thinking processes. Interpretive challenges in feedback are known to cause communication problems for students and instructors (Sadler, 2010). Due to the implicit nature of the expectations and assumptions, there was an absence of mutual understanding between the design teams, the client and peers about the (sub)problems present in the designs. Since the teams did in general not use the feedback to subject their design to any critical evaluation (CT) in order to detect these (sub)problems, there was no need to generate new ideas (DT) to elaborate or adjust the design. Critical evaluation appears to not come ‘naturally’ to the children, a notion that is supported by research done by Blom and Bogaers (2018) in the field of Linkography with young novice designers (age 13-14 years).

Furthermore, the parrying of feedback by the design teams suggests that they might have felt a high level of attachment to their design ideas. This could have made it difficult for them to decide to accept or reject the feedback, since their abilities to objectively consider the feedback might have been impaired. Literature shows that high levels of ownership can create feelings of loss when confronted by suggestions for change, making people less likely

to fully adopt the given feedback (Baer & Brown 2012). Yet, we must note, that in itself, feelings of ownership can also have a positive impact on developing promising ideas of which their potential is not immediately recognized. A designer has to develop the skills to be able to balance between remaining open to possible flaws within the design ideas, yet also persistent in developing a promising idea despite receiving negative feedback (Crilly, 2015; Csikszentmihalyi, 1999).

Ultimately, it appears that there is a need for guidance on deciding what to do with each piece of feedback; (partly) accept or (partly) reject. The development of critical thinking skills are needed in order to objectively explore the feedback before accepting or rejecting it. Novice designers must learn to suppress the tendency to immediately reject criticism, and 'temporarily accept' it in order to explore its merit.

Conclusion

Earlier research emphasizes that feedback has the ability to encourage a designer to take DT as well as CT paths during their design process (Cardoso et al. 2014; Yilmaz & Daly 2014, 2016). Nevertheless, our results show that feedback on design ideas does not necessarily help young novice designers (children age 9-11) to engage in divergent and convergent thinking processes. Our study shows that divergent feedback will not necessarily promote divergent thinking processes and convergent feedback will not necessarily promote convergent thinking. Resistance responses were widespread. The novice designers frequently rejected feedback immediately instead of accepting it temporarily in order to explore its merit. This led to stagnation of divergent and convergent thinking processes within the teams, resulting in a lack of critical reflection and a loss of openness which hampered the creative process. We point to the assumptions and expectations of clients and peers that were only implicitly present in the feedback on the design ideas as one of the factors sparking this resistance in design teams. We therefore suggest (1) the use of concrete convergent feedback followed by (2) divergent feedback in order to regain openness and spark new creative thinking processes.

We believe that feedback from clients and peers can still be a fruitful strategy in learning to be creative and to apply DT and CT thinking. However, all parties involved – teachers, clients and pupils - need to learn to give and receive sound feedback. Feedback conversations should be constructed carefully, as they are sensitive and filled with fragile egos, sensitive identities and insecure learning processes (Dannels, 2011; Goldschmidt, Hochman, & Dafni, 2010; William, 2018). What is being said and by whom, and the reactions that follow, create a complex minefield in which all participants need to learn to navigate. We suggest that, design feedback needs to be concrete and should clearly explain any expectations and assumptions the feedback giver might have about the design in order to reach a mutual understanding. When a mutual understanding is reached about the (sub) problems within the designs, there is room to regain openness and use divergent feedback questions in order to spark new DT processes. Additionally, the development of critical thinking skills could help young novice designers to objectively explore the feedback before accepting or rejecting it.

Limitations

This article has some limitations due to the focus on the responses directly after the feedback was given. It is possible that in some instances, the feedback may have instigated the concurrent divergent or convergent thought processes at a later stage within the teams.

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