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TRANSFORMING THE COMPLEXITY OF A THEORETICAL FRAMEWORK INTO AN EXPERIENTIAL DESIGN METHODOLOGY FOR DESIGNERS

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ABSTRACT

In design, a wide range of design tools and techniques that are derived from theoretical frameworks have been developed. However, there are only a few that consider the perceptual qualities involved in interaction. Although existing tools are widely adopted, designer's need for considering theoretical notions of ecological perception (Gibson, 1986), embodied interaction (Dourish, 2011) and affordances (Gibson, 1986; Norman, 1988; Hartson, 2003) has not been addressed in the context of design tools. This paper describes the development of an experiential design method card system based on the Interaction Frogger framework (Wensveen, 2004). The design method card supports designers to better understand the perceptual qualities of interaction design and convey this knowledge into their design processes. First, we introduce various theoretical frameworks that deal with perceptual qualities within interaction design, particularly focusing on the Interaction Frogger framework. Consequently, we investigate how a complex theoretical framework can be translated into practice utilising a design tool, by examining a case study of developing a set of design method cards. This set of method cards was examined by means of focus group sessions with design researchers and redesign exercises with designers and design students from various backgrounds. Throughout the redesign exercise, the experiential nature of the method cards system helped designers and design students to gain insights into perceptual information exchanges that emerge between objects and users. Furthermore, the method cards gave them a systematic platform for these insights to be reapplied into their design process. Overall, the design method card system provides opportunities for design practitioners, researchers, and students to explore perceptual qualities within the interaction design space and further an opportunity to utilize theoretical knowledge in a practical design process.

Keywords: Design Methodology, Design Toolkits, Ideation Tools, Evaluation/Methodology, Theory and Method, Interaction Design

1 INTRODUCTION

This paper describes the development of a design method card system based on an interaction design framework to support designers to better understand the perceptual qualities involved in interaction design and to convey this knowledge in the design process. While design approaches such as *Participatory Design* (Schuler, 1993), *User-centred Design* (Vredenburg, 2002), *Experience-Centred Design* (Blythe, 2006) and *Design for Children* (Bekker and Antle, 2011) utilize a wide range of tools and methodologies that are derived from various frameworks, there are few design tools or methodologies that consider

perceptual qualities of interaction. Although these design approaches are complimentary to each other and existing tools are widely adoptable, designers' need for considering theoretical notions of *Ecological Perception* (Gibson, 1986), *Embodied Interaction* (Dourish, 2001) and *Affordances* (Gibson, 1986; Norman, 1988; Hartson, 2003) has not been addressed in these design approaches.

The importance to consider these notions has been discussed widely in various grounds, ranging from defining theoretical ground of certain notions (Vermeulen et al, 2013) to using these notions to generate certain aspects of design (Hummels, 2008). Especially, notions like *Feedback*, *Feedforward* and *Affordances* (Gibson, 1986; Norman, 1988; Hartson, 2003) are often overlooked in the design process and they are implicitly applied in the design where designers are not aware of how these notions are utilized. Vermeulen et al. (2013) suggested that this is due to lack of a well-defined and widely accepted definition of these notions. We argue these notions are not represented in a way that they are relevant enough for designers to integrate them into their design implementations. The frameworks that address these notions often rely on their abstractness or explained with the examples that are no longer relevant. For example, the notions like *Feedfoward* are open to several interpretations where their comprehensibility depends on the examples (Vermeulen et al., 2013). Further, these examples are often explained with obsolete technologies like *portable Mini-Disc player* (Dix et al., 2008). The issue of frameworks being abstract, thus making them hard to be used in design practice, does not only apply to the above mentioned notions. Hornecker (2010) suggested that while frameworks on tangible interaction provide a better understandings and common vocabularies, their focus on analytic nature makes it difficult to provide procedural guidance and hard for them to be integrated into creative ideation process. Consequently, indicating the issue of integrating theoretical understandings and creative idea exploration lies within the analytic and abstract nature of frameworks across various design fields.

In this paper, we propose a form of representation that could transform the complexity of a theoretical framework into a practical tool of synthesis for interaction design. It is argued that structural constrains of theoretical frameworks often benefit the creative process where central tenets of the process need to be emphasised (Hornecker, 2010). Thus, we begin by describing various theoretical frameworks that address perceptual qualities within interaction design, particularly focusing on the *Interaction Frogger* framework (Wensveen et al., 2004). Accordingly, we discuss the possibilities to transform theoretical complexity of a design framework into the practicality of a design tool by examining three case studies, where we describe the development process of design method cards system based on the *Interaction Frogger* framework (Wensveen et al., 2004). The main aim was to explore the possibility to educate designers and design students, to provide a better understanding of perceptual qualities within interaction design and enable them to utilise the theoretical knowledge in their design process. Furthermore, we investigated corresponding methodological approach through exploring design approaches like *Experience Prototyping* (Buchenau et al., 2000), *Bodystorming* (Burns et al., 1994), and *Role Playing and Low-fi Prototyping* (Ehn et al., 1988). The design method cards and the methodology were examined by means of a research-through-design approach (Zimmerman et al, 2007), where they are applied in initial ideation process and various stages of design processes with designers and design students from various backgrounds. Further, we discuss possible future application areas for the design method cards and the methodology, within

interaction design field.

2 BACKGROUND

2.1 DESIGN FRAMEWORKS AND TOOLS

The notable benefit of analytical design methods is that they enable the designer to incorporate the necessary knowledge into various stages of the design process (Bekker and Antle, 2011). Furthermore, these design methods are derived from theoretical or empirical knowledge that have developed and accumulated along with design experiences and design research (Vermeulen et al., 2013). However, the theoretical knowledge is often not applicable in design due to its abstractness, thus not accessible to designers. Theoretical notions such as ecological perception (Gibson, 1986) and embodied interaction (Dourish, 2011) and certain notions of phenomenology (Merleau Ponty, 1969) are often referred to by various design researches and applications (Wensveen et al., 2004; Hummels and Overbeeke, 2008; Deckers et al., 2012). However, they often fail to describe explicitly how these notions are used and applied in the design process.

There have been various attempts to make these hard to grasp notions more accessible for designers to implement them into their designs. Hiding the complexity from the designers and generalising the knowledge to be applicable in various contexts (Bekker and Antle, 2011) is one of the examples of the approaches that have been suggested to make these notions more accessible. Some of the notions that have been practically applied and of which the process of application is explicit are *Feedback*, *Feedforward* and *Affordances*. Various frameworks that highlight the notion of Gibson's (1986) affordances have been suggested and utilised across the field of interaction design. Among them, notable ones are Gaver's (1991) *Technology Affordances*, Hartson's (2003) *Four Kinds of Affordances*, Dix's (2009) *Modelling Devices for Natural Interaction*, and Wensveen's (2004) *Interaction Frogger*. Each of these frameworks deals with the notion of *Affordances* in different ways (Vermeulen et al., 2013). Vermeulen et al. (2013) suggested that this lack of clear definition and acceptance of notions are the reasons behind designers not being aware of these design aspects like *Feedforward*. Thus, the opportunity to explore this notion of *Affordances* or *Feedforward* in their design process is lost.

In their attempt to emphasise the importance of *Feedforward* in various frameworks and reframe the notion of *Feedforward*, Vermeulen et al. (2013) have emphasised comprehensiveness of Hartson's (2003) framework and practicality of *Interaction Frogger* (Wensveen et al, 2004). Moreover, Dix et al. (2008) suggested that due to *Interaction Frogger's* systematic approach and its intention to understand what makes interaction natural through emphasising particular qualities influencing the interaction, such as time, location, direction, dynamics, modality and expression, it inlines with their interaction model for natural interaction. These qualities that determine the nature of the relationship between *feedback*, *feedforward* and their consequent actions, defines the practicality of this framework for designers to utilise them in their exploration and implementation of natural interactions. These are the qualities, which we would like to resort to for its practicality in implementing design method cards.

2.2 INTERACTION FROGGER FRAMEWORK

The framework addresses the theoretical notions of feedback, feedforward and affordances and its relationship to user's action by emphasising the six aspects of perceptual qualities that enable designers to analyse and explore the richness of the interaction. Therefore, the framework consists of the following types of feedback and feedforward, based on the sort of information perceived by the user and the six aspects of natural coupling that determines nature of the relationship between action and perception.

Inherent Feedback/Feedforward: deals with information related to the *action possibilities of the product* and appeals primarily to the *perceptual motor skills of the user*.

Augmented Feedback/Feedforward: deals with information from an additional source implemented.

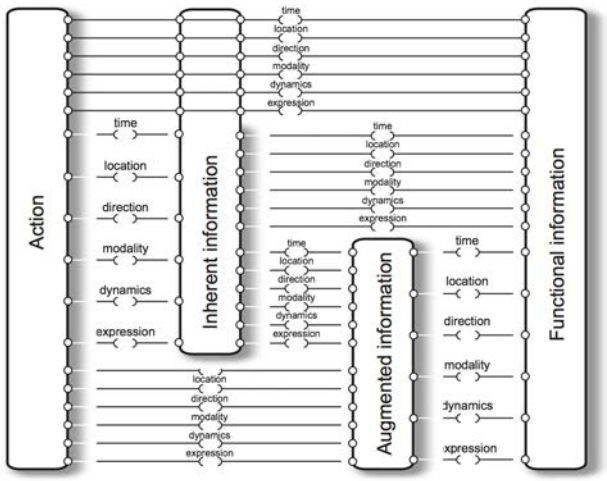
Functional Feedback/Feedforward: deals with information about the general purpose of a product and its functional features.

Six Aspects of Coupling: these consist of aspects that determine the nature of the relationship between the action and perception (feedback and feedforward) and how they are mapped to each other. The six aspects deal with Time (when, duration), Location (where), Direction (scale, orientation), Modality (5 human senses), Dynamics (rate of changes), Expression (Perceptual Interpretation).

The notion of mapping, nature of coupled aspects and their explorative nature is what makes *Interaction Frogger* framework a suitable foundation for a systematic and a practical method tool for analysis as well as synthesis. Mapping of *feedback/feedforward* to a certain action can be regarded as direct and natural, where six aspects of coupling are implemented accordingly. Thus, creating a natural interaction. On the other hand, these coupled aspects could be exploited to create certain influences on the qualities of interaction. These notions of mapping and coupling are unique to the framework where other frameworks focus on the definition of *feedback* and *feedforward*. And they are the manipulation points where these aspects can be explored to achieve a certain kind of interaction, whether it is inviting, or inhibiting (Stienstra, 2012).

3 THE DESIGN METHOD CARDS

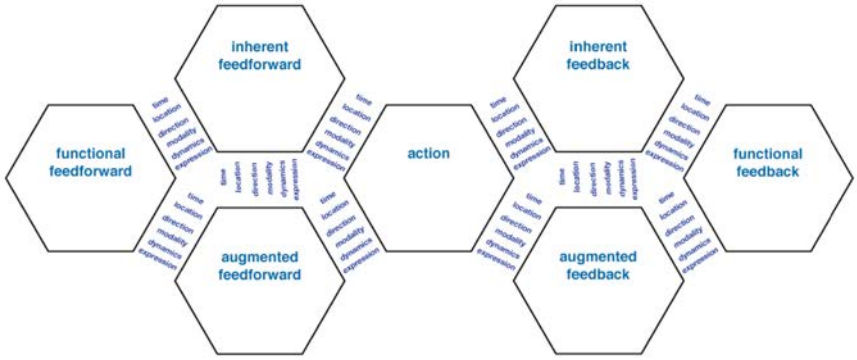
Method cards enable the conceptual knowledge of design frameworks to be more accessible as well as reusable in the design process (Bekker and Antle, 2011). The physicality of cards limits the information to be clear and concise, while it enables the diverse applications. Due to its versatility, cards form of design tool has been widely adopted, such as Hornecker's (2010) card brainstorming game, PLEX cards (Lucero et al, 2010), Inspiration Card Workshop (Halskovand and Dalsgård. 2006), IDEO Methods Cards (IDEO, 2003), and Developmentally Situated Design cards (Bekker and Antle, 2011). In each of these cases, the purpose and approach of their usage ranges from inspiration and brainstorming in early design stage (Hornecker, 2010; IDEO, 2003) to analysis and evaluation of design in the later stage (Bekker and Antle 2011). Further the reason behind adopting the cards approach also varies widely from the affordance of their physicality (Lucero et al, 2010) to multiplicity of cards to convey diverse



information (IDEO, 2003).

Figure 1 –Original representation of Interaction Frogger Framework

As Bekker and Antle (2011) suggested, a card set is a design tool that enables the conceptual information to be more accessible to designers. Further, the card set is a representation of the conceptual information. As Wensveen et al. (2004) originally represented the framework in a form of horizontal bars and connecting lines (Figure 1) and later it is represented by hexagons and connecting aspects of couplings (Figure 2) (Stienstra et al, 2012; Chaboki et al, 2012), the current design method cards would represent and communicate this conceptual



information with a new form.

Figure 2 –Varied representation of Interaction Frogger.

3.1 DESIGNING FROGGER CARDS

Through development and evaluation of the Frogger Method cards and accompanying methodology, we attempted to address the following three issues that are often associated with design method cards. First, a better communication and representation of the complex and abstract conceptual knowledge. Second, providing a better understanding and educational values through emphasising systematic and practical aspects of the conceptual knowledge. Third, facilitating discussion and collaboration for designers to explore the aspects of interaction design that the conceptual knowledge

highlights. As part of research-through-design approach, the design method cards in context of its design and applications were explored and evaluated iteratively. Through examining three use-case sessions, involving design researchers, students and practitioners, the design method cards and the methodology were examined. Consequently, we reflected upon gained insights and applied them to improve the development along the observations in each iteration. This constructive design approach (Koskinen et al., 2011) both

supported the development of the design method cards and allowed us to gain insights into how designers experience and utilise the cards.

Figure 3 –Frogger Method Cards, example cards.

The Frogger Method cards consist of 12 example cards (Figure 3), where they describe examples of interaction with simple daily objects in the context of *Interaction Frogger* framework. Further, diagram cards and role cards are provided to assist in evaluating the nature of interaction in each example card. The examples are mainly drawn from daily objects and they are distributed over three categories, mechanical, analogue and digital objects. According to Wensveen's (2004) description, mechanical objects like a pair of scissors provide a close mapping between action and perception that has natural couplings in each coupling aspect. Furthermore, each category reflects the variations in mappings and couplings that can be found easily within daily objects. For example, a mechanical coffee grinder has close mapping between action of rotating the grinder's handle and the perception of coffee being ground through resistance, smell, and sound, which in turn creates natural interaction. Meanwhile, the electrical coffee grinder has a looser mapping between action and perception, where action of rotating the handle is replaced with pushing a button, which in turn changes couplings of certain aspects like direction. These moderate changes across the categories help the designers in understanding the subtle differences and overall effect of that difference in experience of the design. Each example card displays the illustration of the object on the front and a brief description of related action and aspects of perception on the back (Figure 3) The top corner of the cards are colour coded in accordance with

categories; mechanical (red), analogue (green), digital (blue). The description on the back consists of information about typical *Action* you would take to use this object, *Types of Information*, which explains the inherent, augmented and functional elements, *Nature of Information*, which describes feedback and feedforward elements and *Six Aspects of Coupling* that elaborates on the degrees of coupling in each aspect.

In order to explore the potentials of these cards as an experiential understanding tool as well as a generative tool, we have implemented a methodology that incorporates aspects of *Body Storming* (Burns et al., 1994) and *Role Playing* (Ehn, 1988) approach. In the process of using the cards, designers are asked to pair up as a group. Each group is given three diagram cards (one for each category) and six role cards (one for each category per person). They are then presented with example cards to choose from. For the initial experience with the cards, they are asked to choose one example that they would experience the interaction through playing a role of a user and an object. In this role playing, the designers are encouraged to use their body to act out the given interaction, while in the process they can closely examine the mapping between action of the user and the perceptual information that the object gives out accordingly. To further this exploration, they are asked to choose an example of an object that has same functional purpose but is in a different category, to examine the difference. In addition, they are asked to redesign the interaction through examining and manipulating the existing perceptual information. After exploring and experiencing the interactions, they are encouraged to record their understandings and discussions on the diagram and role cards provided.

The experiential methodology in combination with the design method cards provides several advantages to the Frogger Method cards system. The most notable advantage would be the possibilities for designers to take an object's perspective in understanding perceptual information. Thus providing an insight into different aspects of perceptual information that previously understood only from user's perspective. Furthermore, this experiential approach encourages the designers to understand and generate through utilising their bodily movements, which highlights the importance of *Embodied Perception* and *Kinaesthetic Creativity* (Svanæs, 2013). Thus, it enables the design process to convey the notion of *Embodied Interaction* (Dourish, 2001), providing an opportunity to incorporate theoretical knowledge.

4 THE SESSIONS

The main purpose of these sessions was to evaluate aforementioned potentials and benefits that the Frogger Method cards system could provide. Three separate sessions were carried out, with design researchers, practitioners and students. One of the goals was to explore the methodology's acceptability and relevance across design education, research and practice to determine directions for further development of the design method cards and the methodology.

Each session consisted of three sub-sessions of 30 minutes explorations; example exploration, re-evaluation/redesign of explored examples, and concept generation based on the redesign. The sessions were recorded on video, and group discussions were recorded on the diagram cards and role cards, where individual perspectives of the exploration and design process were recorded. The videos were roughly transcribed, mainly focusing on the bodily movements

demonstrated. The data gathered, videos, pictures and transcriptions, were used in post-hoc analysis of the methodology's educational, practical relevance in various design stages and contexts. Consequently, we describe each of the three sessions, focusing on the progressive results of the discussions and the outcomes.

4.1 SESSION 1: DESIGN RESEARCHERS DISCUSSION

This This session was organised to get an initial impression of the Frogger Method cards by inviting six design researchers from Technical University of Eindhoven, The Netherlands. They were knowledgeable in various theoretical frameworks including *Interaction Frogger* framework and were able to create a dialogue around the potentials of this methodology as a synthesis tool for designers. The session consisted of a design exercise to explore chosen interaction examples on the card with their bodily movements, in order to redesign the interaction, while maintaining the overall functionality of the object.

Each group was asked the following questions regarding the example cards they selected.

- *For each object, how does each of the six aspects of coupling influence the overall interaction quality?*
- *How does the difference in one or more aspect(s) of coupling change the overall interaction quality?*
- *Could these coupling aspects be adjusted with moderation, in order to create a desired interaction quality?*
- *How does having an object's perspective change the interaction qualities in design process?*

All three groups in the session have created interesting variations to the interactions of existing daily objects. Some were more conceptual, expressive, and functionally limiting, while some were very functional and could potentially be directly implemented into a design. Discussions often lead to a debate of terminologies, however, when they started exploring the interaction with their bodily movements, the discussions became more of a creative and explorative tool than a debate tool. Although the exploration of interactions with their bodily movements resulted in somewhat limited interpretation of the example descriptions, the essence of interaction qualities and perceptual information exchanges were clearly present. With these elements, each group could moderate and change the overall interaction qualities. The bodily movement oriented methodology encouraged more direct experiential exploration, resulting in very expressive concepts, meanwhile discussing different perspectives of the user and the object gave them better insights into more elemental aspects of the concepts. Often these two opposite, holistic and analytical aspects of the design process were applied in different stages of design explorations. However, by bringing them together, they could directly feed each other, making the creative process more fluid. Furthermore, this nature of the methodology enabled them to overcome the limitations of technology centric, device centric or user centric approaches of conventional design processes.

4.2 SESSION 2: DESIGN PRACTITIONERS AND STUDENTS REDESIGNING TECHNOLOGY

Second session was organised with a combination of design practitioners and design students from the Royal Melbourne Institute of Technology University, Australia, in order to examine the potentials of the system to be a generative design tool as well as an educational tool. The main aims were to gain general opinions and interests from design practitioners and getting specific feedbacks from students in terms of its educational values.

The design brief that was presented to designers and students stated following: *"Through redesigning objects from the past, make the objects more relevant to the current social and technological development."*

Some of the example cards describe objects from the past where these objects are obsolete, such as a rotary phone. When these cards are compared to functionally equivalent object cards with improved technology, the cards and the methodology provided first-hand opportunities to explore the perceptual difference in interacting with these objects. Thus, the discussions raised from these comparisons gave a better insight into the relationship between the technology implemented and the interaction that each of these objects mediates. The examination of this relationship resulted in various design ideas where the focus was in the perceptual qualities within the interaction rather than the technology itself. The design challenge existed in reconsidering the existing perceptual qualities through bodily movement explorations, thus re-evaluating the aspects of obsolete technologies that still holds their relevance in current society.

Each pair went through three stages of explorations, ideations, discussions and demonstrations where they picked two or more examples of same family of objects, explored and discussed the interaction, and translated them into bodily expression and communicated to the overall group. At each stage, the overall group discussed the aspects of interaction qualities, in the context of *Interaction Frogger* framework and tried to determine overall nature of the interaction and how each aspect of natural couplings influences it. These discussions provided foundations for next stages, where it raised the important comparison points in the second stage and helped them in a creative direction in redesigning process in the third stage. For example, a group explored the difference between a rotary phone and a digit phone, while examining how the interaction of making a call changed more intuitively in regards to technological development. Within the exploration of how the rotary phone is used, the discussion was focused on the technological implementations and its limitations. However, the focus shifted quickly as they compared the rotary interaction with the digit interaction, emphasising the interaction qualities and their values of rotary mechanism, thus resulting in creative exploration of these values (Figure 4).

Figure 4 –Session 2, movement exploration of rotary & digit phone.

4.3 SESSION 3: DESIGN STUDENTS SHAPE-CHANGING HOUSEHOLD OBJECTS

The third session was organised with seven master students from Technical University of Eindhoven, The Netherlands, where they were asked to use the Frogger Method cards system for their two-weeks design project. In this design project, they were asked to design household objects for future living with consideration for shape-change technology. The main aim of the session was to evaluate the design method cards and the methodology in the context of designing for emerging technology.

The design brief emphasised following aspects of investigations; "*explore the aspects of interaction qualities exist in presented examples of objects and Identify elements of perceptual qualities that reflect potential applications for shape-changing technology and modulate these elements to change overall qualities of interaction."*

Initial exploration consisted of understanding the existing interaction qualities through bodily movements, and identifying elements of perceptual qualities that would have potential applications for shape-changing aspects of redesigned objects. The physical nature of bodily movement explorations enabled the participants to easily realise the potentials of shape-changing aspects to be redesigned. Further, the object perspective of role-playing approach provided a unique insight into kind of movements and embodied perceptual information that could be implemented in the redesigned object. The discussion was mainly focused on the qualities of physical movements that existed within the interactions and the kind of perceptual information embodied within various implementations of these movements. For example, a group explored the movements of a manual and electrical coffee grinder, where they explored the relationship between the rotational movement of the handle and the blade. Through understanding this relationship, they could identify perceptual elements resulted from rotational movements of both the handle and the blade, which lead them to explore the expressive qualities of these rotational movements.

Further, this insight was utilised in their redesigning process, where they implemented similar relationship in an interaction with a shape-changing eggbeater. In this redesigned concept, the manual eggbeater handle was

reimagined to change its shape, depending on the progress of whipping action (Figure 5). Overall, the bodily movement exploration provided an experiential and embodied facilitation, while the descriptions on the cards guided them to identify crucial elements of perceptual qualities within the exploration.

Figure 5 –Session 3, redesign with shape-changing technology.

5 CONCLUSIONS AND FUTURE WORK

While theoretical frameworks address crucial aspects of design, they are limited by their complexities and abstractness in informing design process. To overcome this limitation and transfer theory-based knowledge into the design process, various design tools and methodologies have been proposed across design fields (IDEO, 2003; Halskovand and Dalsgård. 2006; Bekker and Antle, 2011). However, these tools and methodologies often neglect to consider perceptual qualities of interaction that various frameworks address (Gibson, 1986; Dourish, 2011).

This paper described the development of a set of design method cards and a methodology that are informed by *Interaction Frogger* framework (Wensveen et al., 2004) to support interaction designers in better understanding the perceptual qualities and enable them to apply these theoretical knowledge into synthesis process of design space. Different from most cards based design tools, the Frogger Method cards system provides structural elements of perceptual aspects that designers could understand, explore and modulate, while bodily movement exploration and role-playing aspects provides experiential insights into these perceptual aspects of interaction.

The contribution of this paper is on three levels. First, the transformation from its representation as the framework to the design method cards, enabled designers to understand perceptual qualities in interaction design in the context of analysis, conceptualization and synthesis. Moreover, the experiential oriented exploration methodology further expanded this understanding into design activities. Second, the methodology addresses importance of the experiential qualities within the design process and implementing such qualities into design tools. Third, the importance of experiential qualities within the Frogger Method cards system emphasizes the role of the methodology where bodily movements and role-playing enhances the understandings of the theoretical knowledge.

Overall, the case studies have demonstrated how the design method cards support in understanding and adopting *Interaction Frogger* framework (Wensveen et al., 2004) in the context of design process.
Finally, further research is required to determine what level of understanding acquired in the process of utilising the Frogger Method cards system, in comparison to designing the theoretical description of the framework. In addition, an investigation with respect to the designs emerged from designers adopting the Frogger Method cards system needs to be conducted. However, the appreciation of the Forgger Method cards system by the participants involved in our sessions support us to continue exploring the design method cards as a easy-to-use and engaging way for learning about and incorporate complex theoretical knowledge into the design process. Consequently, we hope that the design method cards and the methodology will enable better incorporation of concepts relating to rich interaction into design practice.

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