Understanding the Usefulness of Ideation Tools with the Grounding Lenses

David Chung  
National Taiwan University of Science and Technology  
Taipei, Taiwan  
puromitheus@gmail.com

Rung-Huei Liang  
National Taiwan University of Science and Technology  
Taipei, Taiwan  
liang@mail.ntust.edu.tw

ABSTRACT  
Many design studies were focused on how to form a card-based inspiration tool to support designers in the early stage of their design process. Although there is a great deal of studies on bridging the gap between design theories and instances through card-based design, however, there is little guidance, on how to pragmatically evaluate the usefulness. Using a set of deck, Interaction Tarot, based on the structure of Tarot, as an example, this paper argues that the Horizontal and Vertical Groundings (HG & VG), often used to generate intermediate-level knowledge such as strong concepts [12], can serve as analytical criteria for evaluating the quality of card-based design tool pragmatically. To address this, we conducted an HCI workshop with multiple brainstorming sessions with Interaction Tarot. The questionnaire data, tool usage, and interview accounts are categorized or quantified with respect to HG & VG, to ascertain how a card-based tool helps designers facilitate the design ideation in practical use. The findings could provide proper empirical evidence to demonstrate how design researchers use the set of two lenses (HG & VG) to have better understandings of a card-based tool in supporting the design inspiration.

Author Keywords  
Design methods; design practice; ideation; embodied user interface; creativity support tools; interaction design.

ACM Classification Keywords  
H.5.2. User Interfaces: Theory and Methods.

INTRODUCTION  
There has been an increasing interest in developing a card-based tool for design ideation (see for example [1, 6, 10, 13, 14, 15, 16, 17]). While all use different forms of design inspiration to facilitate ideas, their arguments seem to serve as “—”intermediate-level knowledge residing between particular artifacts and general theories” [12]. Some scholars have articulated that a card-based design tool can be used to explore specific problems in design ideation. For instance, Golembewski [10] used Ideation Decks to define the problem space, revealing that card-based tools can help designers have a thorough understanding of the design space before brainstorming [10]. In order to explore the utilization of the design framework and inform tangible interaction system, Hornecker [13] presents a card-based brainstorming exercise, which is transformed from four abstract concepts with a game format. The game does not provide guidelines to restrict thinking, but offers provocations and colloquial questions for designers. This approach could be used as a tool to sort and filter out ideas. Exertion Cards presented by Mueller follow a similar approach to supporting the design process [19]. He devised his own framework by transforming it into a design tool to support the hands-on practice. Both of the above studies consider that frameworks and theories are too abstract to be used in the design practice. Most of them claim that their card-based design methods are a useful thought-provoking tool for designers to facilitate the creative process, and most of cards are intended to explore and narrow down the design space. However, there are rare discussions on how to effectively evaluate the usefulness of a card set. Since exploration and convergence are also regarded as two crucial approaches to constructing intermediate-level knowledge and there are existing discourses about it, as a consequence, we suggest that a systematic approach based on the construction method of strong concepts [12], which is a form of intermediate-level knowledge proposed by Höök & Löwgren, can serve as good criteria for evaluating the quality of a card-based design.

Before going any further, we would like to define several research terms we will use in this paper. Contextual Grounding (CG) we understand as the grounding that should be abstracted from a real case of particular use situation when forming a strong concept [12]. We will use Horizontal Grounding (HG) to refer to the related concepts that help to paraphrase the design space, and Vertical Grounding (VG) highlights the bridging between a concept and its related design instances or design theories. The goal is to illustrate the triangulation of empirical, analytical, and theoretical groundings, and to revise appropriate strong.
concepts for particular use context. The importance of specifying these definitions, we hope, will quickly become apparent.

Recently, design theorists and researchers have also investigated the intermediate-level interaction knowledge: how the knowledge actually works behind practice. Various groups of researchers have worked on constructing knowledge based on the design-oriented research [9, 12, 16]. In 2013, Löwgren addressed the role of intermediate-level knowledge in interaction design research [16], and suggested that there are different types of intermediate-level interaction knowledge, such as patterns, experiential qualities, strong concepts, annotated portfolios, etc., which reside between particular artifacts and general theories. Turning the design notions into an ambiguous form of thinking is also a kind of discourse, and helps designers understand more easily. It is quite different from the logic of deduction in scientific research, since designers usually concern how to constructively explore and converge ambiguous ideas rather than positivistic experiments.

On the other hand, most of the previous studies argue that card-based ideation tools could explore and narrow down the design space, but often ignore comprehensive evaluations of card design. This implies that designers use cards to construct common intermediate-level knowledge through similar exploration and convergence. Therefore, we argue that understanding card-based ideation tools could be based on how they facilitate intermediate-level knowledge construction, which has been proposed theoretically [12] and could provide analytic lens for comprehensive evaluations.

The purpose of the study is to pragmatically examine the usefulness of a card set and broadly explore the role of intermediate-level knowledge in the early stage of a design process through an analysis of the quantified data, card usage, and categorized accounts based on the HG and VG criteria. To address the issues already outlined and to begin to fill the gaps in the previous research, the present study is designed to address the following research questions:

- What are the general methods (grounds) that can comprehensively evaluate thought-provoking tools accessible for designers?
- How do we strike a balance between abstract concepts and particular artifacts to dynamically revise appropriate contents of individual card through such criteria?

In this paper, we will focus on the discourse of a card-based tool for design ideation, how to develop and formatively evaluate it, and what the significance of such method is. The next section will outline the previous studies about brainstorming activities, card-based tools, and the intermediate-level knowledge. Then, we will briefly introduce the development of the prototype of Interaction Tarot, which provides us a comprehensive perspective of possible interaction design issues to bear intermediate-level knowledge, and explore the possible problems for designers based on our studies on their practical use. The findings collected from practical use of experts’ suggestions provide us some specific understandings to adjust the information hierarchy of this deck. After a series of discussion, reflection, we deploy the final prototype of Interaction Tarot in an HCI workshop. In order to understand whether each concept on a card of the deck can be used effectively in brainstorming sessions, we will present the coded data from interviewees’ accounts as empirical evidence based on analytical criteria that we claimed. Through an evaluation process, articulation and reflection based on HG and VG are presented, and then we will provide further discussions and conclusion in the final section.

**BACKGROUND**

There are lots of tool kits for ideation in HCI community. In this section, we will further investigate how to hold an effective brainstorming activity, how to use a deck in an ideation session, and the introduction of strong concepts. Thus, this pilot study can support designers with solid theoretical basis in designing a deck for ideation.

**Brainstorming**

In the early phase of design, there are various ways to make ideation workable [4, 7, 8, 20]. Brainstorming is one of the most popular ways to do creative thinking in the empirical domain. We refer to “Designing Interactions” by Bill Moggridge and “The Art of Innovation” by Tom Kelley [15, 18], and summarize them with five important tips below for session leaders:

- Encourage ‘Yes’ and ‘Yes’: welcome ridiculous ideas.
- Encourage ‘Quantity’: A hundred ideas per hour indicate a good session.
- Rapid prototyping makes ideas tangible and better on the next round.
- A designer is not only an observer, but also a situated participant.
- Mesh-up: Good idea may be combined by other ideas.

**Card-based design tools**

Recent studies on card-based design tools suggested that cards are indeed beneficial to idea inspiration in their creative process (see for example [1, 2, 3, 6, 10, 11, 13, 14, 17, 19]). These specific benefits include bridging the gap between design theories and design practices [2, 6, 11, 13, 17, 19], focusing on how to design a useful information in a hierarchy of a set of card deck [6, 17], and offering a continuous question rather than a fixed answer through designing the card deck [14], while some design tools were transformed from their abstract framework, with focuses on embodied interactions to understand the user experience [13, 19]. In addition, other researchers stimulated creativity with provocations and colloquial questions [1, 17]. Each set of cards provides a useful tool for designers to facilitate imagination in the design practice, and enables designers to have adequate understandings of the surrounding concepts.
in the early stage of their creative process. However, there are rare discourses on how to formatively evaluate the usefulness of a card deck. For instance, there is a lack of the evidence of usefulness in [14], and [17] did not articulated how to comprehensively evaluated card-based tools but focused on how to design the deck. Besides, most prior studies highlighted the contribution of their decks through observation and rough transcription with few participants (e.g. [1, 2, 3, 13, 17]) rather than providing an overall understanding of card usage. Even, researchers tried to compare their inspiration method with related methods but they did not propose formal criteria for rigor study [11]. Thus, the limitation of previous studies is that most researchers could not clearly claim what the characteristics of their design of a tool is and how well enough it is during the ideation process.

The intermediate-level knowledge
Recent design-oriented research has suggested that intermediate-level knowledge may indeed bridge the concepts between abstract theories and design instances in several different ways. These specific prior works include bridging concepts [5], annotated portfolios [9], strong concepts [12], etc. Bridging concepts [5] discoursed about the connections between theory and design practice through theoretical ground, articulations, and exemplars. Gaver proposed annotated portfolios [9], which make similar annotations into a portfolio, reflecting designers’ interests, considerations in their crafting, the motivation of making, and what they concern about society. Höök & Löwgren [12] proposed strong concepts, aiming at fostering construction culture with intermediate-level knowledge for design-oriented research. Strong concepts are some elements or principles for design practice, and they can be used to construct artifacts in any context. As shown in the above literature review, existing research seldom discussed research methods of how to comprehensively evaluate the quality of card-based ideation tools. Hence, in order to fill this gap in our understanding, we suggest that a systematic method based on the construction guidance of strong concept [12]. HG and VG can serve as a set of two lenses for evaluating the quality of the card deck at any level of abstraction.

PROTOTYPE DEVELOPING

Tarot card as the design material
Prior studies provided us some guidance while posed certain limitations to a design work. Based on those studies, we chose the structure of Tarot card deck as our design material. We believe that a useful deck needs to include the overall interaction possibilities, and to consider the situation of real usage. Based on CG, presented by Höök [12], and prior studies, our team investigated what kinds of interaction forms to live with us and how to balance the abstraction of strong concepts between general concepts and particular artifacts. Instead of allowing empty/blank cards (e.g. [3]) for designers to create their own design notions, we believed the archetypal structure of Tarot, which is empirically regarded as “general and broad” enough to cover all issues in a life world as our design material. Besides, its underlying structure inspired us to develop related meaning clusters, in a hope to cover as broad issues as possible grounded in interaction design rather than grounded in a specific context. The interaction design issues we care about between technology and lived world are in analogy to the perspective of ancient people who explored the association between this unknown universe and human beings. Further, we transformed the meaning clusters to interaction design notions as the main concepts of our interaction design deck, Interaction Tarot, to quickly inform designers for inspiration and imagination.

Prototype implementations
The prototype is a set of 22 rectangle cards with rounded corners, approximately 75 mm by 115 mm in size. The copy can be downloaded from http://interactiontarot.wordpress.com/. Based on the characteristics of card titles, we classify the cards into 3 categories: 8 cards with green color are Value\(^1\) cards, including Vision, Resource, Fun, Care, Personal, Future, Emotion, and Responsibility, 8 cards with orange color are Method cards, including Aesthetics, Balance, Function, Form, Material, Search, Ritual, and Metaphor, and 6 cards with pink color are Interaction cards, including Random, Intercultural, Social, Sharing, Compete, and Communication.

Once we have confirmed these main concepts, on the front side of each card we created paintings with abstract expression according to the meaning of each card and its metaphor (Figure 1). Although the main concepts were able to reflect the overall interaction design notions, we thought it might be too general for novices to draw inspiration. Therefore, we added related concepts and one question behind the card to avoid the possible frustration by the unclear semantics. Thus, researchers invited 8 graduate students who are familiar with interaction design to have more fertile imaginations on designing the information features of related concepts on the other side of each card. Each meeting lasted 1 hour and the participants were asked to separately give each card some annotations according to the original meaning of its main concept. We coded the collected annotations, following CG from [12] and the symbolic meaning of Tarot. Although more related annotations for each concept would provide more inspiration to novice users, we were afraid that too much information would blur the concept and distract the brainstorming. After carefully sorting, synthesizing, and discussions, for each card we suggest 11 to 13 annotations as our related concepts were better with regard to the layout.

\(^1\) We use bold font when we refer to the card categories.
of the bottom of the back side of each card. They are not only highly related to the main concept but also easy to be understood and associated. Meanwhile, based on the main idea of each card, we developed a design question respectively to encourage critical thinking. Finally, we understood that the complicated information features of a card “could defeat its purpose” by repeated use [6]. Thus, our visual designer struck the balance between openness and explicitness to find the appropriate information hierarchy of categories, design question, main concepts, and related concepts by considering all possibilities in font size and colour coding carefully. We aimed to provide optional information for designers if necessary rather than persuade them into framing ideation with such layout. After the tool preparation, we decided to investigate the real situation and effectiveness of the card’s use to obtain evidence for the better understanding of Interaction Tarot. Drawing on the theoretical framing (HG & VG), we were able to see if there were the triangulation of empirical, analytical, and theoretical groundings, and we would revise appropriate concepts for particular use context.

Figure 1. Interaction Tarot, taking the Aesthetics Card as an example: the front side (Colour Cover and Main Concept), and the back side (Category, Question, Main Concept, Related Concepts, and Related Cards).

RESEARCH METHOD
After we explored a balance between abstract concepts and particular artifacts in designing card features, we conducted a workshop with multiple sessions and did research through observing participants and analytical discussion to separately investigate the real situation of the card usage based on HG and VG.

Design workshop
Interaction design workshop, OpenHCI 2014
We conducted an HCI workshop, OpenHCI 2014 (Figure 2), in which cross-disciplinary groups with different interests and backgrounds could work together and structured their concepts during a week (from July 6th to 11th). The goal of this workshop was to explore what interaction possibilities would be in the lived world. As a result, we organized the team members including students from Computer Science and Design to leverage knowledge from Computer, Digital Media, Design Thinking, Psychology, and other disciplines. The advantage of grouping a cross-disciplinary team might take the Medici Effect, which often occurs when we bring different kinds of concepts from the original field into a new territory [21].

Participants
We invited 16 graduated students who were either good in design practice or well understanding Arduino programming as our teaching assistants. Then, we gave them a series of training about how to be a facilitator to hold a brainstorming session in the workshop. The participants in the study are 48 graduate students. The participants include students from a wide range of academic areas, and all of them are interested in interaction design.

Figure 2. The Design Workshop, OpenHCI 2014 with Interaction Tarot over multiple brainstorming sessions.

Task in OpenHCI 2014
Based on prior studies of brainstorming, we have more understandings on how to hold a better brainstorming session with Interaction Tarot. In order to compare the difference between brainstorming sessions with card-based tools and those without, we conducted two brainstorming sessions with the same participants, issue, and task duration, but with different ways to facilitate them.

<table>
<thead>
<tr>
<th>OpenHCI 2014</th>
<th>Participants</th>
<th>Issue</th>
<th>Session Name</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstorming (Day 1)</td>
<td>8 groups (8 participants, 2 TAs/group)</td>
<td>Black Holes in the space-time of Universe</td>
<td>Warm-up exercise</td>
<td>15 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brainstorming without Interaction Tarot</td>
<td></td>
<td>100 min</td>
</tr>
<tr>
<td>Brainstorming (Day 2)</td>
<td></td>
<td>Black Holes in the space-time of Universe (the Lag of Time, Space, Social, and 5 Sense)</td>
<td>Warm-up exercise</td>
<td>5 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Sessions [ &amp; ] - Assign</td>
<td>Horizontal Sessions [ &amp; ] - Random</td>
<td>20 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Questionnaire time</td>
<td></td>
<td>5 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical Grounding</td>
<td></td>
<td>50 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Questionnaire time</td>
<td></td>
<td>5 min</td>
</tr>
</tbody>
</table>

Table 1. The brainstorming sessions in day 1 and day 2. Brainstorming in Day 1 did not use the Interaction Tarot, but Day 2 did over two groundings.

Further, we prepared warm-up exercises for participants to know each other well before their ideation. As shown in
Table 1, Horizontal Grounding consisted of two rounds: Assign and Random. In the first round, each participant was asked to select one card of the best relevance to the issue from the deck, and in the second round, each was asked to draw one card from the deck randomly for design ideation. In Horizontal Session I of each round, the facilitator should encourage participants to think wildly and focus on quantity rather than share their ideas immediately until the following Horizontal Session II, where each participant presented her/his ideas and shared briefly. Horizontal and Vertical Groundings were both followed by a questionnaire, and were used to reflect the different bridging dimension on HG and VG respectively.

Data collection
The questionnaire for Horizontal Sessions consisted of four dimensions to explore the card usage, the first of which was intended to ask the real situation on card drawing. The second dimension asked participants to rate the degree of the usefulness according to how they paraphrased the design space (HG) of the chosen card. Dimension 3 focused on the perceived usefulness regarding each card. Finally, the fourth dimension was designed to assess opinions of the information features of the chosen card. The questionnaire for Vertical Sessions consisted of four dimensions to explore the card usage, the first of which was intended to ask the real situation on card drawing. The second dimension asked participants to rate the degree of the usefulness regarding the bridging between the chosen card and its related design instances or design theories (VG). More open-ended research problems were presented in the third dimension, in which participants were asked to answer what related concepts of the chosen cards are used to create new ideas. Finally, participants were also asked to make general comments for the brainstorming with card-based inspiration tool. In these two questionnaires, when responding to a usefulness problem, participants were briefly asked to specify their level of agreement or disagreement on a 5-point Likert scale; on the other hand, when responding to an open-ended research problem, participants were asked to make comments on the questionnaire. After the workshops, we interviewed 16 facilitators (TAs) of 8 groups as the participants to obtain retrospective data on the brainstorming meeting; logistical issues prevented us from interviewing all the participants. Interviews lasted for 60 minutes and all responses were recorded for further analysis. Moreover, the collected data from questionnaire and interview enabled us to verify the card usage and to gather extra understandings, which might be of interest for subsequent analysis.

Data analysis
The interview data were intended to serve as an additional source of information to validate the questionnaire survey. The first author read all the transcripts first. On a second read, the first author marked salient excerpts that illustrated the interviewees’ beliefs about usefulness of each card. The salient excerpts were organized into 10 meaningful units, including ‘the horizontal grounding of each card’, ‘the vertical grounding of each card’, ‘information features’, ‘usability’, ‘brainstorming graphic organizers’, ‘warm-up exercise’, ‘holding skill of each facilitator’, ‘general opinion of the workshop’, ‘other tool usage’, and ‘special opinion about card-based inspiration tool’. These meaningful units will be discussed as examples of ideation process and be used to triangulate participants’ response to the questionnaires based on HG and VG.

RESULTS
In this section, we present two formative evaluations following the two criteria, HG and VG. 97.9 percent of questionnaire returned, and the results are interpreted cautiously. Therefore, the evidence of the usefulness of individual cards comes from not only the analyzed survey data collected from all participants’ opinions, but also the retrospective data from interviewing 16 facilitators (TA).

Evaluation with respect to HG
Objective facts on card usage
As given in Table 2, we objectively count overall production of post-it notes with respect to two rounds (Assign & Random) of the Horizontal Grounding, and we list the usage of each card in sequence. ‘c/d-1’ and ‘c/d-2’ represent the Counts of post-it notes created for a single Drawing of a specific card in round 1 and round 2 respectively. And ‘C/D’ counts the average distribution of each drawing in two rounds (Figure 3).

<table>
<thead>
<tr>
<th>Interaction Task</th>
<th>Assign count</th>
<th>Random count</th>
<th>Total count</th>
<th>C/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0.43</td>
</tr>
<tr>
<td>Personal</td>
<td>25</td>
<td>3</td>
<td>11</td>
<td>0.67</td>
</tr>
<tr>
<td>Balance</td>
<td>28</td>
<td>2</td>
<td>14.00</td>
<td>0.71</td>
</tr>
<tr>
<td>Search</td>
<td>26</td>
<td>2</td>
<td>13.00</td>
<td>0.73</td>
</tr>
<tr>
<td>Fun</td>
<td>49</td>
<td>4</td>
<td>12.50</td>
<td>0.75</td>
</tr>
<tr>
<td>Emotion</td>
<td>49</td>
<td>6</td>
<td>3.67</td>
<td>0.50</td>
</tr>
<tr>
<td>Resource</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Future</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Function</td>
<td>10</td>
<td>1</td>
<td>10.00</td>
<td>0.10</td>
</tr>
<tr>
<td>Ritual</td>
<td>23</td>
<td>3</td>
<td>8.33</td>
<td>0.35</td>
</tr>
<tr>
<td>Intercultural</td>
<td>70</td>
<td>0</td>
<td>17.50</td>
<td>0.25</td>
</tr>
<tr>
<td>Care</td>
<td>25</td>
<td>3</td>
<td>6.50</td>
<td>0.26</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>15</td>
<td>2</td>
<td>9.00</td>
<td>0.25</td>
</tr>
<tr>
<td>Material</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Metaphor</td>
<td>19</td>
<td>5</td>
<td>15.00</td>
<td>0.25</td>
</tr>
<tr>
<td>Sharing</td>
<td>30</td>
<td>0</td>
<td>10.00</td>
<td>0.25</td>
</tr>
<tr>
<td>Competence</td>
<td>20</td>
<td>3</td>
<td>6.50</td>
<td>0.15</td>
</tr>
<tr>
<td>Communication</td>
<td>64</td>
<td>6</td>
<td>10.67</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 2. The numbers of ideas created from each card.

In the first round, there were four cards that were not chosen by any participants, including ‘Responsibility’, ‘Resource’, ‘Future’, and ‘Material’. When they were asked to randomly choose a card in the second round, the random selection would force the participants to choose from the unused (remaining) cards. The average c/d-2 is 10.56 (ideas per drawing), and thus, there were more than 10 ideas related to ‘Future’ and ‘Material’ per drawing, and there
were 9 ideas related to ‘Resource’ per drawing. However, the result showed that the idea counts related to ‘Responsibility’ was much below the average level. Although this card, ‘Responsibility’ was revised before, it seemed as if this concept with the information features on it was still hard to stimulate participants’ horizontal imagination. As shown in Figure 3 and Table 2, ‘Intercultural’, ‘Metaphor’, ‘Form’, ‘Random’, and ‘Material’ could better support participants’ horizontal ideation, while ‘Responsibility’ and ‘Vision’ did not. However, the case with ‘Vision’ is very different from the ‘Responsibility’ since ‘Vision’ card was not randomly drawn out in the second round. In order to accommodate such kind of unexpected condition, we looked for another kind of investigation data to evaluate the usefulness of individual cards in the next figure.

![C/D](image)

Figure 3. ‘C/D’ counts the average idea production of each card drawing in two rounds.

**Subjective statements**

![Subjective statements](image)

Figure 4. The subjective statements of users illustrate the perceived usefulness.

In addition to the objective facts, we also investigated the subjective statements, which are evaluated with a legitimate measurement by [19] in CHI2014 for similar card-evaluation in a massive-participant workshop (Figure 4). Each participant was asked to circle the card as useful or non-useful for ideation in the questionnaire survey. Moreover, we present qualitative results in the next section to strengthen our arguments on cards’ perceived quality. Figure 4 presents that all cards are useful, although they differ in certain degree. One hundred percent of all respondents agreed that ‘Communication’ is easy to use. The majority of respondents also expressed a strong agreement for perceived usefulness when they used the cards, such as ‘Emotion’, ‘Sharing’, ‘Intercultural’, and ‘Social’. Over half respondents said that they would like to use those cards: ‘Compete’, ‘Metaphor’, ‘Material’, ‘Aesthetics’, ‘Care’, ‘Ritual’, ‘Function’, ‘Future’, ‘Form’, ‘Fun’, ‘Random’, ‘Search’, and ‘Personal’. However, more than 70% of respondents indicated that they would not like the use of cards ‘Responsibility’ and ‘Vision’, and they were not really satisfied.

**Triangulation analysis**

We made reinterpretations of the two evaluations which present objective facts and subjective responses, respectively. First of all, we sorted 22 cards by their actual idea counts per drawing in a descending order (blue bars in Figure 5); for example, Intercultural card is of the highest C/D and scaled as 22 while Vision card is of the lowest C/D and scaled 1. Then, the scale by the subjective perceived usefulness is of the same rule (red bars in Figure 5).

![Ranking and cross-checking](image)

Figure 5. Ranking and cross-checking the C/D (the counts of idea production per drawing) and PU (perceived usefulness).

As shown in Figure 6, we cross-checked the ranking of two indicators and got more detailed information of the situation. The cards located in the blue circle of Figure 6 are not only regarded as useful but also very generative in the real situation, such as ‘Communication’, ‘Intercultural’, ‘Form’, ‘Sharing’, ‘Metaphor’, and ‘Fun’. The cards located in the green one are easy to use but considered as “not so useful”. The cards located in the yellow one are perceived as “useful” but indeed hard to use. The cards, ‘Ritual’, ‘Resource’, ‘Responsibility’, and ‘Vision’ located in the red one do neither seemed to be actually useful nor perceived as useful in this experiment. Apart from the plot, we triangulated the survey data with interview accounts from 16 teaching assistants (facilitators) to prevent the intrinsic
biases, to compensate for the lack of understandings from the quantitative survey.

![Figure 6. Triangulation analysis of survey data indicates the facts on card use.](image)

To get a better understanding of each card, we analyzed the meaningful units corresponding to ‘the horizontal grounding of each card’ as we described above, and then the usefulness and limitation emerged:

- **Different appropriateness in different Issues**: P2 said: “...for this topic, ‘Ritual’ is good to use, because it can inform us the routines in our daily life, such as the detail about ordering meals... ‘Fun’ is easy to use because of the main concept, other concepts, such as ‘Search’, this concept would be directly related to ‘Google’. Lots of members of my team claimed that they would search someone’s name on the Google, when they want to know him/her more... for me, ‘Emotion’, ‘Form’, ‘Care’, ‘Search’, ‘Metaphor’, and ‘Compete’ are easy to do brainstorming, on the contrary, some cards are not useful, such as ‘Intercultural’, ‘Vision’, ‘Aesthetics’, and ‘Future’... especially, the card ‘Vision’ causes me to have negative thinking...” Interviewee’s opinions are not in contradiction with those of the empirical data analyzed as aforementioned statements. We believe that there exist appropriate concepts for different issues, and such kind of characteristics, what we called ‘diversity’ is excellent to a card-based inspiration tool.

- **Limitation**: P7 had further discussion about Responsibility and Vision in regarding to their issue: “...generally speaking, ‘Responsibility’ is not useful, since we cannot establish a sound relationship with ‘Responsibility’ and our issue... ‘Vision’ is always ignored... our issue, ‘Lag on five sense’ and ‘Vision’ we selected is too big to draw inspiration, and ‘Vision’ is also hard to have relation to our life experience... but, ‘Ritual’ has more strong connection to our life...” With regard to the useful cards, he said: “…if the issue is more specific or small, such as the experience of playing with the sand and water, then, ‘Communication’ would let me think more problems about how to across the barrier of... ‘Social’ inspires me to think about cooperation with someone... ‘Emotion’ drives me to memorize the experience of playing sand by a particular trace...” Some facilitators indicated that the contents of cards might influence the ideation, taking P4’s opinion as an example: “…why not using ‘Culture’ as the main concept? I think ‘Intercultural’ is too narrow to foster creativity...”

**Evaluation with respect to VG**

After the brainstorming sessions that expand participants’ horizons, participants were asked to converge and group several wacky ideas to significant patterns, and to think about what problems they concerned or what phenomena they would like to explore in this workshop. As shown in Figure 7, we just count the numbers of cards that were directly used in the Vertical session. In order to gain more user experience, we analyzed the meaningful units corresponding to ‘the vertical grounding of each card’ as described above, and the usefulness and limitation emerged:

- **Cards as categories for idea sorting**: The facilitators have their styles on holding a brainstorming session, for instance, P7 commented, “…we kept cards that are interesting to us, and gave up those uninteresting ones...” Some facilitators used other tools to sort ideas, P13 said, “…I lead them to converge by colorful stickers...” Interaction Tarot help designers focus on a specific concept, as P4 said, “…we converged and had some categories, including ‘Intercultural’, ‘Balance’, ‘Value’, ‘life, and option’... these two card (Intercultural and Balance cards) are very impressed... ‘option’ is something about opportunity... we considered that ‘intercultural’ is very similar to ‘Communication’, and grouped them together.” P5 and P6 lead the same group, and believed that “Our team members used the cards they drew as the categories for idea sorting, such as ‘Communication’, ‘Sharing’, and ‘Social’ were put together... some ideas that are related to ‘Emotion’ were put together either... by the way, they often expressed their ideas by painting...” P16 commented: “…their ideas turned toward ‘Communication’ and ‘Intercultural’ in the Vertical Session; as a result, they conceived the experience of seeing a foreigner in the airport and ‘Bottleneck Effect’.” Likewise, from the interviewee’s opinions, other facilitators, including P1, P12, and P14, also observed that team members used cards as a sorting tool for their convergence.

- **Limitation**: Few TAs reflected that it is difficult to converge in ideation with Interaction Tarot, such as P1 criticized: “…they should vote the ideas that they created...
in the previous session rather than using cards directly...the cards are too general to be used for sorting ideas...” P8 similarly indicated: “…it might be hard from cards to specific artifacts...I think the card deck is a reference…”

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**Figure 7. The amounts of cards directly used in the Vertical Session.**

**DISCUSSION**

To conclude, the present study is a preliminary research on how analytical criteria would be for evaluating the quality of individual cards within Interaction Tarot, but its relevance to card-based brainstorming research can also be seen. The major findings below are organized from a set of two lenses, HG and VG, which can formatively evaluate thought-provoking design tools accessible for designers. The results indicate that card-based tools not only provide diverse dimensions for designers to do ideation but also bridge the concept between theories and instances. However, it remains unclear, what the appropriateness is, while concerning annotated portfolios of interaction design in ideation collectively.

**Research findings**

Following a triangulation analysis of the quantified data, card usage, and categorized accounts based on HG and VG, we have pragmatically examined the usefulness of a card-based tool, with 6 findings emerged as the following:

**Staying focused while encouraging imagination (based on criteria HG)**

We aim to encourage designers to create more imaginations rather than to restrict their thinking through a card-based tool, Interaction Tarot. As P4 admitted: “…cards provided some surrounding concepts to my team members, and they only expressed their own topics at first...I believed that there were some conceptual relations among each cards...that would not restrict ideas, actually, the effectiveness of this tool depends on facilitators...” P2 has similar comments: “…for me, cards give me a variety of dimensions to do think instead of restricting my thinking…” P7 recalled, and said: “…sometimes, they used cards to do more inspiration, while they were blocked...” Among all teams, the one that most frequently uses Interaction Tarot on idea creation is team 7. Their TA (P13) said: “…I observed that they are more familiar with card use in the round 2 of the horizontal session than in the round 1…” In addition to the card use in day 2, they used Interaction Tarot to do convergence again in the day 3 of the workshop. When we interviewed P13, she said: “…We seldom used Value cards in our first brainstorming until day 3 brainstorming...they started noticing and using those cards that belong to the Value category, and used these cards as ‘anchors’ to do convergence and divergence again...they focused on ‘Fun’ and ‘Care’ to discuss...the second consideration of card chosen is more specific...” P14, another facilitator of the team 7, claimed: “…Cards help them horizontally explore more aspects of an issue…” Even, after the workshop, they were still talking about Interaction Tarot in their personal meetings in cafeteria, P14 said: “when I asked them, all of them agreed that Interaction Tarot is useful. It was hard to do imagination without Interaction Tarot at the beginning (day 1). On the contrary, it was easier to do brainstorming through cards than non-use…” To sum up, as the frequency of use increases, users can better understand how Interaction Tarot works. Besides, Interaction Tarot indeed offers sufficient concepts and rich symbolic meanings for users.

**Diversity of Interaction Tarot (based on criteria HG)**

From the Interviewee’s opinions we described before in the result section, we observed two extreme cases, ‘Intercultural’ and ‘Ritual’, and we believed that there exist appropriate concepts for different issues in Interaction Tarot. Moreover, its own kind of diversity would benefit card-based design research. P8 insightfully mentioned that: “…Interaction Tarot itself is diverse, which allow them (team members) to think more.”

**Profound Insights gained from the triangulation analysis (based on criteria HG)**

The researchers have better understanding on the usefulness of each card through the cross-checking ‘C/D - Order’ (the amounts of idea production per drawing in descending order) and ‘PU - Order’ (perceived usefulness in descending order) as shown in Figure 6. The four colored circles provide design researchers profound insights on what the imagination potential of an individual card is, how to improve the favorable but actually not so useful, and unfavorable but actually useful cards, respectively. The solid evidences which came from the cross verification take a dialogical approach between design researchers and users.
Breakthrough ideas from cooperation (based on Criteria VG)

Interaction Tarot is used as common language for group communication where they could contribute their domain knowledge [6]. P13 said: “…taking ‘Ritual’ as an example, it is usually neglected and overlooked, however, the ‘Ritual’ gave them a cue to discuss more information about their life. Besides, this word was often used to anchor what they mention for…” Further, she stated: “…from my observation, I found that their ideas were interactive with those in different issues in Interaction Tarot…” Nevertheless, P3 had an unfavorable observation results: “…common language? Maybe, but I think it is not obvious. I think they just you know, extend their ideas, again and again…” The researchers got more discussions from another facilitator P4, who is in the same team with P3: “…some key words would be joined together to do brainstorming, for instance, the post-it notes extended from ‘Intercultural’ and ‘Communication’ were discussed together…”

Other facilitator, P11, observed an interesting situation: “…some participants articulated their ideas through sketch, such as message in a bottle, paper airplane, speaking tubes…” speaking tubes was extended form ‘Communication’ and ‘message in a bottle’ & ‘paper airplane’ were extended from ‘Material’ later. There are rare discussions about speaking tubes until they saw the ‘Material’, thus, they started discussing about the prototype and thinking more about that… message in a bottle & ‘paper airplane’ are expressed by sketch…” We highlight this case and argue, what they discuss is about the media of ‘Communication’; further, they organized the different ideas from different cards to co-create breakthrough ideas implicitly. The effects of card-based design were emerged from an unexpected play or serendipitous exploration of Interaction Tarot. Taking the Team 3 as an example, both facilitators of T3 (P5, P6) recalled: “…they developed a concept about personal debt APP in the warm-up exercise, where there was a greedy sheep in your iPhone. When you owe someone money, the sheep will grow up as the tolerance of your friend is broken, finally, the sheep will yell at you…” P5 and P6 claimed this topic, ideated from their card playing at the early stage of brainstorming, was a common language and was involved in the further discussion of the workshop. There is a similar observation on Team 4 and Team 5 either. P7 shared her findings, and stated: “…in the warm-up exercise, they used the cards, including ‘Function’, ‘Random’, ‘Care’, and ‘Form’, and imagined a possible picture about exchanging the perspective of insects and human beings. That’s a story about animal care and this, was as a common language to them…” P9, a facilitator from Team 5, also shared a funny finding: “…their common language is from the warm-up exercise at Day 1, it was a topic about ‘pu pu’. They used this topic and ‘Fun’ to co-create a variety of funny ideas…”

Like other Intermediate-knowledge, Interaction Tarot provides physical and non-physical anchor to allow users to have their ‘Ideas of Collage’.

Interaction Tarot could bridge the abstract theories and design instance (based on Criteria VG)

Although there was no strong evidence of how Interaction Tarot bridges the ideas and design theories, the results indicated that there were complex, diverse, and breakthrough concepts which were articulated, sketched, and produced in various forms. From the triangulation analysis of the meaningful findings above, Interaction Tarot could support the idea sorting of designers. Among the interviewee’s accounts, P1, P4, P5, P6, P7, P12, P13, P14 claimed that their team tried to use Interactions Tarot as a part of design material to sketch or prototype their concepts, on the other hand, there were only one facilitator (P16) stated their team recall the theories in the Vertical Session. More importantly, this study fosters a constructive culture in HCI research of intermediate-level knowledge, which bridges the abstract theories and design instances.

A comprehensive evaluation (based on criteria HG & VG)

In this paper, we propose a new method to comprehensively evaluate the card-based inspiration tool. The triangulation analysis discoursed in the previous section gives design researchers and designers an overall point of view on how to fine-tune the cards according to the inclusion of HG aspect, perceived usefulness and idea production of users, as well as the inclusion of VG aspect, abstract theories and interaction design instances. As we can see from the view point of HG, the idea quantity objectively indicates what the significance of intermediate-level knowledge is, and how the individual one encourages wider inspirations, and the other aspect from perceived usefulness provides the researchers with implicit evidence from users. On the other hand, from the perspective of VG, theory level demonstrates how the intermediate-level knowledge offers the general theories to design researchers while in terms of the level of design instances, the knowledge may provide innovative and reasonable ideas to designers in their design practice, such as sketch, mock-up, and prototypes, etc. To sum up, what we offer here is a new method to evaluate the quality of a card-based inspiration tool, which might consist of intermediate-level knowledge at any level of abstraction, while the quality of ideas created and how to generate a better ideation tool are beyond our concerns in this paper.

Limitations and future work

Despite the advantages of a card-based inspiration tool, it does have certain limitations. It is hard to strike a balance on providing abstract concepts that is good for both HG and VG at the same time for each user. A big challenge we faced is that forming a deck of mixed levels of abstraction in Interaction Tarot might reside at different levels of abstraction in intermediate knowledge, because the ambiguity of some concepts might be too general to inspire ideas and the others might be too specific to ideate. We argue that the usefulness of Interaction Tarot depends on user’s domain knowledge. However, our intention is to present a new research method to comprehensively evaluate
the quality of ideation tool, rather than a discourse on how to generate the Interaction Tarot and an interpretation on how to inspire concrete design. Moreover, card-based tools might all suffer from the problem that categorization might limit one’s idea as much as it inspires. Although we have the practical experience that the broad and diverse archetypal structure of our cards appears to alleviate the problem, it definitely needs further investigation in future works. Through the exemplar we proposed in this paper, we opened a new beginning for further understandings and focused critiques of card-based design. For the future work, we would like to create the cards in different forms, such as an App-based tool in mobile devices, exploring new possibilities of Interaction Tarot based on the criteria, HG and VG, with additional methods as we proposed in this work.

CONCLUSION
In view of a wealth of the ideation deck in prior works without rigorous ways to understand it, it raised our attention to have comprehensive understandings about it. Meanwhile, we think thoroughly understanding it is as important as practically constructing it. Therefore, we propose a new method based on HG and VG criteria for evaluating the quality of a card-based inspiration tool. With the criteria we proposed, design researchers would tease out profound insights from the ideation tools through the cross verification and such descriptive exemplar. A set of two lenses will not only support the designers to revise the information features of Interaction Tarot, but also allow design researchers to obtain a better understanding of card-based design in the future. We argue that the criteria are not a standard of measurement but rather a crucial probing, which offers further studies on how to evaluate card-based ideation tools. We hope this study will be able to leverage further works of how to evaluate a thought-provoking deck with formative criteria and help consolidate the study of intermediate-level knowledge within the HCI research community.

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