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Designing Learning Opportunities in Interaction Design: Interactionaries as a means to study and teach student design processes

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Learning by practice, apprenticeship and paradigmatic examples have been prime paths for learning within interaction design. These have been criticized for being time-consuming and costly, of not being implementable in academic contexts. In this article we suggest and evaluate a pedagogical model to address these problems in design teaching and learning. Results from a time-constrained collaborative design exercise, a so-called "interactionary", are presented. Student design work is analyzed using the framework of learning design sequences and analysis of the primary transformation unit shows that interactionaries reveal patterns in student design work. Materials are used mainly to document design ideas rather than as a design material to further investigate design ideas and aspects of interaction. In the critiquing sessions, regarded as the secondary transformation unit, many issues hardly addressed during the design work were brought up. Thus, the designers continued to develop their design proposal primed by critique presented by the reviewers. Based on the results, possible teacher interventions to coach student design work are suggested.

BACKGROUND

Interaction design is about designing novel user interfaces and proposing ideas about the future use of artifacts (Löwgren & Stolterman, 1998). Creating representations of such future interaction is a task that is difficult to learn, describe and teach as the object of design is of such an abstract and intangible character (Reimann, 2008; Saffer, 2006). Both Reimann and Saffer emphasize conceptualizing working situations and empathy with users.

According to Löwgren interaction design is about creating conditions for

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good use of digital designs and maintains that the "only way to learn those conditions, to understand the relations between design choices and resulting use, is still largely by practice and apprenticeship" (Löwgren, 2002, p. 1). Also more specific skills within interaction design have been claimed to be developed with practice, as maintained by Bill Buxton "a designers' use of [sketches] is a distinct skill that *develops with practice*" (Buxton, 2007, p. 96).

Intimately connected to the strong emphasis on practice is the importance of not only learning in formal settings but also being exposed to authentic cases. Strong and colleagues pointed out already in 1994 the need for "an experiential component as well as classroom instruction" in HCI education (Strong et al., 1994, p. 12). Further, even though novice interaction designers *do* get involved in authentic cases, there is still the challenge of providing appropriate coaching (Sas, 2006b).

Most design activities are not performed in an isolated context but conducted within an interdisciplinary context with different actors having different roles in regard to a design task. Collaboration is important as a way to reflect on ideas, sketches, design elements or context of use (Artman, Ramberg, Sundholm, & Cerratto-Pargman, 2005; Ramberg, Artman, Sundholm, & Cerratto-Pargman, 2004; Sundholm, 2007). Collaborative design can be viewed as an activity driven by communicative practices and representations for mediating ideas. Sketches and other intermediating artefacts, not the least language, become important to communicate and present design ideas and concepts. Designers must learn not only visual design, but also how to negotiate the relation or the interplay between some actual system design and design of use (Arvola & Larsson, 2004).

CONCEPTUALIZING INTERACTION DESIGN EXPERIENCE

A specific form of capitalizing on experience of design is various *conceptualizations* of design ideas. One structured approach to capturing design ideas from experience is by identifying and describing design solutions in terms of design patterns as advocated originally by Christopher Alexander (Alexander, 1977). While originating in architecture, design patterns have in recent years received considerable attention in human-computer interaction and interaction design (Dearden & Finlay, 2006), and interaction design education (Karlgren & Ramberg, 2012). By providing a conceptual structure, design patterns support the identifying of and communication

about design ideas that can support learning.

Within interaction design, sketches and different kinds of prototypes are frequently used as representational tools for testing, evaluating and communicating ideas and concepts. Sketching and design sketches are often recognized as the key elements of successful interaction design practice and a central skill in interaction design expertise (Cross, 2004).

Sketching is useful in many respects but has limited power to represent the essentials of what interaction designers need to focus on, namely interaction itself with its dynamic and temporal aspects. As complementary means, experienced and professional designers seem to use other means such as domain specific talk, moving around pointing and gesturing to build their design (Arvola & Artman, 2006; Tholander, Karlgren, Ramberg, & Sökjer, 2008). Sketching in this respect becomes more of a multimodal activity rather than one of creating a static physical representation of an idea using a particular physical material (paper, clay, etc.). Sketching in the study reported on in this paper has a focus on iterations and transformations of and between expressions and physical representations and how these constitute learning sequences. Particular emphasis is put on; how expressions and physical representations (sketch/artifact) develop over time, how students given a design task organize this process, how they use interaction design concepts, and how they choose to represent design concepts making use of various materials. In other words how the students engage in and make use of various resources in a design activity. From a perspective of teaching and learning of interaction design, these aspects become crucial to understand and consider when planning learning activities within interaction design courses and programs.

DIFFICULTIES IN COACHING THE PROCESS OF DESIGN WORK

A problem is that it is difficult in academic settings to provide students with the experience of designing that is so needed. Corina Sas maintains that "[t]he craftsmanship dimension of design suggests that teaching HCI design cannot be ensured solely on the basis of traditional classroom instruction …" (Sas, 2006a, p. 2). A common way of teaching design is through project courses in which students based on a design brief are allowed to organize their work at their own will and proficiency. Teachers have little control of and insight into the design processes, and assessment is often conducted

based on an end result. Sas further points out that "since the work is mostly outside the class, the guidance that [the students] receive is usually limited…" (Sas, 2006a, p. 2). Moreover, coaching becomes more difficult as the number of students grows.

A number of approaches to design teaching in academic settings have been proposed, e.g., the concept of design studios where students and teachers work together in a dedicated room (Artman et al., 2005; Arvola & Artman, 2008), conceptual support is suggested to provide with tools to use in interaction design processes (Lim, Lee, & Kim, 2011), and, interaction design patterns have also been proposed to aid students in discussing and evaluating ideas and proposals in their design work (Karlgren & Ramberg, 2012). Sas discusses teaching interaction design through practitioners' praxis and describes a method developed to support interactive teaching and learning within interaction design by using an on-line video library of teaching resources (Sas, 2006a). Lundgren and colleagues (Lundgren, Eriksson, Hallnäs, Ljungstrand, & Torgersson, 2006) describe another approach to teaching interaction design through allowing students conduct several related projects within a time frame ranging from two to ten weeks. Student work consists of iterative development of several projects from idea to prototype with various degrees of implementation. Through this, students are meant to gain both theoretical and practical knowledge in development and evaluation of prototypes (ibid.). In an attempt to create a fun way to demonstrate interaction design, Scott Berkun came up with the concept of interactionaries (Berkun, 2001). An interactionary is a pseudo game show type format that allows teams to work on the same design problem under extreme time-constraints live on stage, while being assessed by a judge/audience. Although Berkun's original idea was to create an experiment in design education and to try out a fun way to teach interaction design, the initial attempts were designed to take place on-stage during large conferences rather than in typical educational settings. Through the use of interactionaries, the dynamic intangibles of design in progress could be exposed allowing an audience to listen in on teams and observe how they work. The design teams were free to organize their design work in the way they liked. However, a panel judged them and a winning team was nominated.

Berkun and colleagues organized interactionaries at CHI in 2000 and 2001 and interactionaries were also organized at a national design confer-

ence in Sweden, STIMDI 2000 and at CapCHI 2013. In our work we built upon the interactionary concept and used it as a data collection method for research on design processes and adapted it to fit an educational design setting.

PROBLEM STATEMENT

Traditional paths for learning and developing competence in interaction design such as learning from practice, apprenticeship and paradigmatic examples have been questioned and criticized on various accounts; for being time-consuming and costly, not being implementable in academic contexts, for being a-theoretical, as well as for not encouraging innovation. There is limited time and possibilities to support and coach collaborative interaction design and especially the processes of designing in academic settings. There is a lack of knowledge of how to create exercises when time is limited (cf. various kinds of simulations which are used in many other fields), which can provide experience and for making explicit the design processes of interaction designers.

AIM

In this article we adapt the concept of interactionary with the aim of developing a pedagogical model to support interaction design learning and teaching. To do this we analyze transitions in interaction design students' learning with representational resources and conceptual tools in terms of learning sequences to propose modifications of the model to be applicable in academic learning contexts. In striving towards that aim, the paper further examines how students engage in and frame the design space in terms of both concepts and goals of the future interaction.

METHOD

Eight groups of self-selected interaction design students at university level were asked to work on a task of designing interactive artifacts. The student groups consisted of two to five students who worked together in a spacious room. At the start of the design session, they received a design brief about creating means for interaction through devices supporting twittering, as well as concepts that addressed aspects of interaction relevant to the brief (the concepts of temporality, dynamics, sequentiality, interactivity and

context of use). A strong constraint of the task was further that they were not allowed to use screens in their proposals. They were informed they had five minutes to read, pose questions to the teachers/researchers and discuss within the group. After that they had 25 minutes to both distribute tasks and design their proposal. Besides presenting the task and objective of the study, we did not intervene during the design sessions. During the presentation of the design task we emphasized that they should aim to come up with several design proposals and to have fun. They were asked to create design proposals including an artifact (i.e. a physical representation of the design proposal in a chosen material) and a use scenario with a special focus on interactive aspects of the artifact and its use. The students were further informed they were to give a presentation of their final proposal to another group of students assigned the role of critiquing the design proposal (design reviewers). In contrast to the original interactionary format we decided to not nominate "winners" but instead emphasized how participating and the reviewers' feedback was a good learning opportunity. The students also signed a consent agreement allowing the researchers to use pictures of the design work for research purposes including publishing.

A teacher coached the team of reviewers to prepare them to conduct the design critique. Without knowing what design proposal the design team would present to them, the reviewers prepared general questions based on the five aspects of interaction presented to the design team. The students were also informed that their performance would not be formally assessed since the exercise was not part of their mandatory course work.

We deliberately chose to define so called "wicked problems", i.e., unstructured problems that do not have one single solution. We also chose to define design constraints such as not being allowed to use conventional screens in their design proposals. Further, we allowed the design groups to work on their designs for a longer period of time than that of the original format (25 minutes as compared to 10 minutes). Our motivation for these adaptations of the original interactionary format was to allow the students to reflect on and discuss their work and to push the students to think creatively.

The design groups were provided with various design resources (whiteboard, clay, paper, plastic paper, paper, scissors, Lego™, pencils etc., see figure 1) to use in their design work. The room was spacious enough to allow

the students to diverge and form subgroups to approach different tasks, as they seemed fit. The room was also equipped with a large whiteboard where they could sketch or present flow charts or other notations.

Fig.1:
The design studio with examples of design resources.

The design sessions were video recorded from two different angles by the researchers and the video data was analyzed using an interaction analy-

sis approach (Jordan & Henderson, 1995). The analysis directs particular interest towards how students organized their work in terms of design sequences and how these were handled, their use of concepts adhering to the above mentioned aspects of interaction and materials used in physically representing their design ideas. Moreover, quantitative analyses of how frequently the various aspects of interaction were addressed were conducted.

THEORETICAL CONSIDERATIONS

Learning design sequences are suggested by Selander and colleagues as the key component of a theoretical framework for studying, analyzing and decomposing general and specific learning activities as well as analyzing how different activities are organized (S. Selander & Kress, 2010; Staffan Selander, 2008). The main interest from a learning design sequence perspective concerns the transformations and bridging between adjacent learning situations, and the use of different media and materials in order to reach an understanding of how these are coupled and intertwined systematically (see Figure 2, below). This perspective is particularly apt for the purpose of studying design activities where several modes of expressions are used to represent and present design ideas. This is evident for instance in cases in which designers use gestures rather than words to denote a specific feature of artifacts or sequences of interactions being designed (Arvola & Artman, 2006; Tholander et al., 2008).

According to the learning design sequence framework, learning is defined as "an increased capacity to use signs and engage meaningfully in different situations" (Staffan Selander, 2008, p. 12). This framework allows us to, on the one hand, describe the prerequisites of the design activity (institutionalized learning) and, on the other, describe the "orchestration of modes" (Staffan Selander, 2008, p. 16) in engaging in design activities. In our conceptualization and study the framework allows us to describe the students' capacity of collaboratively making use of various resources (signs) to illustrate and dramatize interactions that are being considered, i.e., multimodal representations.

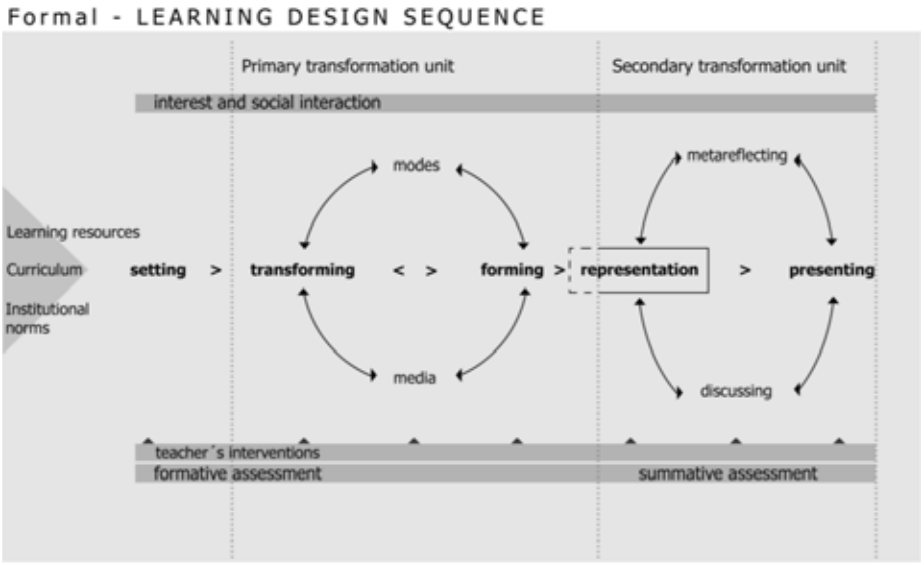

Fig.2:
The Formal Learning Design Sequence Model (Selander, 2008).

Although the interactionaries took place outside of the ordinary schedule of course work, the larger framing could still be experienced as being within the institutionalized setting of university studies. The students recognized us (as researchers/teachers) as representatives of the university and studies at the university. It can therefore not be excluded that this in some way influenced the students and thus also what took place during the interactionaries. Further, in our instructions we introduced concepts that addressed aspects of interaction and by doing this we signaled that these were important to consider and somehow try to use in the interactionaries. This was however one purpose of the interactionaries, i.e. to introduce and investigate how these concepts was used in the design work.

Below, we first present the design work of the groups on a general level and then describe how the students organized their work into different design phases that correspond to different transitions within the primary transformation unit. And finally we describe the primary and secondary transformation units and how the students in these made use of various resources, conceptual and other, in their design work.

We account for two groups of students that represent two different examples of how a design task can be approached. By focusing on the use of different materials in representing and re-representing design ideas, taken together with an analysis of how frequently aspects of interaction were addressed, we could observe how the student groups organized their work throughout the design process. Three raters independently rated the ways in which students addressed the five aspects of interaction. Ratings were based on an assessment protocol defining the characteristics of each aspect. After individual, independent ratings the raters discussed and aligned their ratings. Final inter-rater reliability coefficients were 91% (group1) and 96% (group2). Figure 3 presents the number of cases that aspects of interaction were addressed during the interactionaries over time.

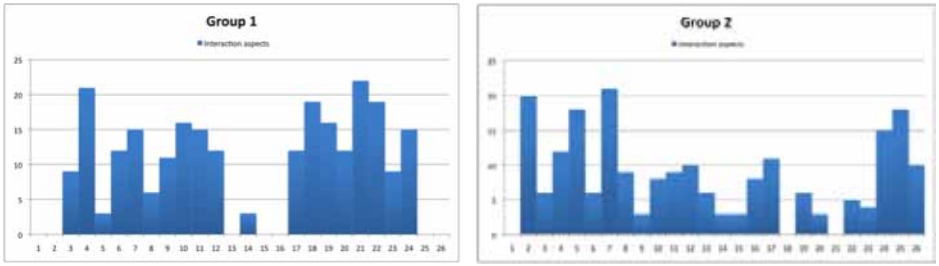

Figure 3:
Number of cases of addressing aspects of interaction during the interactionaries minute by minute.

Our analysis revealed clear patterns in the students' design work. At first students collaboratively discussed possible design ideas making use of spoken language and gestures. This we refer to as the phase of ideation. Roughly ideation refers to processes in which designers try to come to and value ideas in order to come up with promising design ideas to develop. Building on the phase of ideation, the students turned to sketching in a physical material (making use of physical resources), which we have called the phase of sketching in physical materials during which a design idea was realized in some kind of sketch. Finally, the students collaboratively reflected on the

design concept and prototype with a use scenario in mind, a phase we have called verbal reflection. The frequency of how aspects of interaction were elaborated on varied during the design work. As can be seen in Figure 3, it is notable that when students worked with a physical material (such as clay, sketching on paper, etc.) they addressed aspects of interaction to a lesser degree and a discussion and elaboration on these aspects was largely missing (group1: minutes 13-16; group2: minutes 14-22) and focus instead shifted to appearance and physical features. It seems the groups were driven by an idea of producing a tangible artifact and that this was the primary objective of the design task. Thus, design of interaction became subordinate to the physical design, rather than the other way around. Interestingly, both groups showed the same ordered sequence of phases and use of resources, material and other, without being instructed to do so. In the following we will present the primary and secondary transformation units.

THE PRIMARY TRANSFORMATION UNIT

The primary transformation unit began when the students had been given the instructions regarding the design brief and presented with the resources they had at their disposal and ended when the students had designed a physical representation and prepared presentations of the design proposal to be critiqued by other students. The primary transformation unit has been segmented in accordance with the three design phases observed and described above. Moving from one design phase to another we here consider as transitions between representational formats. A transition is defined as a propagation of a design idea into a new representational format.

IDEATION: FIRST TRANSITION WITHIN THE PRIMARY TRANSFORMATION UNIT

The transformation here consisted in interpreting the instructions including the design brief and collaboratively generating ideas to eventually form agreed upon design ideas. The ideation phase more generally builds on discussing and gesturing in order to investigate potential design ideas and enact aspects of interaction.

The two members of group1, in the very first minutes made a connection between what was mentioned in the design brief of physical twittering and the concept of a bird by connecting the brief with tweeting. Their idea built

on a bird mediating interaction between two or more users. The bird concept acted as a guiding concept to the group throughout the whole design process. The concept and characteristics of it in general (i.e. that birds have wings, a beak, two legs, that they tweet etc.) aided them in discussing and coming up with ideas of functionalities. For instance, in minute 3, they discussed aspects of input and output of messages of their design idea. Thereafter they continued discussing aspects of interaction and more precisely how to input data to the bird. In this discussion they acknowledged that they were not allowed to use a traditional screen in their design that seemed to pose a challenge to the designers. Eventually in minute 8, one of the designers presented the idea that data could be entered through lifting of the wing and pushing buttons hidden under it (see figure 4 below). The other designer seemed hesitant to the suggestion and presented an alternative idea of programming the bird by using another artifact, in this case a mobile phone.

She: *the question is only how to make all the settings? How do you set this, should he have this... if you lift one of his wings ... buttons to press on [gestures; clicks on imaginary buttons in the air in front of the other designer] or how should we do this when we don't have a screen?*

He: *mmm… well one could have… you program it via the phone in that case*

She: *yes, that's a good idea*

Figure 4:
Designer to the left mimics lifting a wing to input data pressing buttons hidden under the wing of the bird.

The two designers were guided by characteristics of birds when discussing functionalities and features of their design idea. Their design idea thus not only inspired them and their ideation, but functionalities of it were tightly coupled with physical characteristics of birds. When having agreed on the viability of the concept they moved on to the next phase of representing it in a physical material by starting to sketch a drawing of a bird using pen and paper. In our conceptualization this translates to transitioning to the next phase in the design process.

In contrast, group2 consisting of 4 designers needed more time and discussion to arrive at a viable idea. One person in group2 initiated the design work by presenting a use scenario building on a well-known scenario of a person walking down a street window-shopping in a large city, observing a nice sweater, and wanting to share this finding with a friend by taking a photograph of the sweater and sending it to the friend. The group discussed (minutes 3 – 9) several ideas comparing to hand-like and "mobile things", and also made a comparison to the "Thing" from the "The Adams Family" TV series mimicking a mechanic hand walking on the table in front of the group members.

Having investigated several ideas relating to hands, the group eventually decided that the artifact should have the shape of a hand and they continued to explore ways of how the artifact could convey messages in the form of gestures. For instance, by shaping the hand into a thumbs-up gesture the same gesture was to be mirrored by other users' devices (see figure 5). Soon thereafter they came to the conclusion the artifact should be a "glove" conveying physical messages:

> "it's like a glove - if someone squeezes their hand it will squeeze yours ... and it will crush yours (your hand)"

Figure 5:
Designers illustrating a thumbs-up gesture and how squeezing one's hand is communicated to another user.

Compared to group1, this group to a larger extent explored different design ideas. All of these ideas were related to hands and contemporary handheld devices. The requirements of the brief made them explore the concept of a hand and possible characteristics of hands such as gesturing, squeezing etc. and always carrying it with you. Also in this group the ideation phase was characterized by use of spoken language and gestures to come up with and discuss the general concept. When having agreed on the viability of the concept of glove they moved on to the next phase of representing it physically by sketching a glove on a whiteboard. Both groups thus used their bodies, gestures and spoken language to explore design ideas early on in the design process and seemed to decide on a viable concept to develop further – a concept that continued to guide their design work.

SKETCHING IN PHYSICAL MATERIALS: SECOND TRANSITION WITHIN THE PRIMARY TRANSFORMATION UNIT

In this section we continue by describing how the two student groups formed their design concepts into physical representations and by that also presented their understanding of their design concepts in a different material than that of spoken language and gestures. Based on the rough sketches initiated in the previous transition the students turned these into corresponding clay representations of the design ideas.

In group1 after having sketched the bird on a piece of paper, one of the designers said "*Now let's move on to design*". At this point in their work the designers moved on to working with clay. While having started working on the clay bird the designers focused less on investigating their design idea and instead focused more on the physical form and characteristics of the clay bird, as reflected in figure 3 above regarding use of concepts adhering to aspects of interaction (Group 1). During this phase there was a general decrease in verbal communication and particularly regarding aspects of interaction. Much time was devoted to get the physical details of the bird into place.

The physical construction of the bird was thus primarily focused on its appearance, colors, the legs of the bird and on the materials and tools the designers used; cutting, gluing and fastening bird components, issues of fragility etc. In figure 6 below, the final bird prototype and an early paper sketch is illustrated.

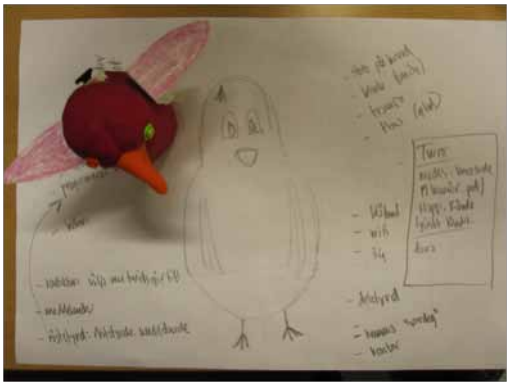

Figure 6:
Paper sketch and clay representation of a bird.

After having designed the clay bird and its physical characteristics, the designers moved on to collaboratively discussing aspects of interaction. These discussions revolved around which functionalities should be added to the bird, where and how these should be handled in interacting with the bird, and how the bird should mediate communication between two users. In discussing these functionalities the designers investigated the physical features of the clay bird and tried to map various functionalities to these. For

instance, in illustrating how to program the bird one of the group members lifted up the bird and started to flap its wings, (see figure 7 below).

Figure 7:
Designer showing how to program the bird by flapping its wings.

Other physical features investigated were for instance the legs of the bird allowing the bird to move up and down, the beak of the bird allowing the bird to make various sounds signifying different communication acts, etc.

Group2 similarly started out with a brief sketch but instead using a whiteboard. One of the group members took the initiative to in front of the other group members sketch a glove and illustrated by enacting how the glove could be used to communicate with others (see figure 8 below).

Figure 8:
Designer enacting how to communicate with other users in front of whiteboard to the left, glove with microphone in the thumb and loudspeaker in the palm of the glove represented on a whiteboard sketch to the right.

Also in this group, when sketching in a physical material communication and discussion in the group decreased and especially aspects of interaction were largely missing (see figure 3). When they on a few occasions did continue to discuss new ways of interacting with the artifact, they did not do so in relation to the clay model. I.e., they did not physically use the clay model to further investigate aspects of interaction but instead relied solely on spoken language and gestures.

REFLECTION: THIRD TRANSITION WITHIN THE PRIMARY TRANSFORMATION UNIT

In the final section of the primary transformation unit we describe how the student groups with a starting point in their physical representations discussed and detailed user-scenarios. Here the groups returned to mainly using spoken language and gestures in order to prepare a presentation for the reviewers.

In group1, contexts of use were mostly just hinted at during the previous phases. Context of use was hardly discussed at all until one of the designers turned to the instructions and read that they should relate to one. In previous discussions they mentioned bringing the bird along in an ordinary bag or in a nest-like bag to a party, or placing the bird at someone's office or in someone's home. I.e. they described where the bird could be brought and placed but they did not elaborate on specific characteristics or use of the bird in those contexts.

In group2, the context of use was to some extent the starting point of the design work. The initial scenario about a portable device that could be carried around in the city seems to have played a major role throughout the design work and they returned to features of this scenario several times (the artifact being portable, walking in the street etc.). They discussed whether it should be worn at all times or if the glove should only be used when communicating. They gave concrete examples such as being at a specific spot in the city (Odenplan) and looking at things window-shopping. These occasional and fragmented ideas of a use scenario were in this final phase returned to and modified into a final and more coherent use scenario when a group member noticed in the instructions that a scenario had to be created. The scenario which was created, gave more weight to the concept of mobile phones leading to the more physically oriented concept (holding or

squeezing someone's hand at a distance using the glove) being lost.

The bird group (group1) emphasized receiving messages through the artifact to a larger extent than the other group that had more emphasis on sending messages. This also became clear in the creation of use scenarios. Here the choice of guiding concept may have played a role, but of course also the perspective taken early on in the design process of either focusing on the sender or the receiver. An alternative to this would of course have been to focus on the interaction and aspects of it. Neither group made use of the physical representation as a resource to come up with and enact use scenarios, thus overlooking the possibility of further inspecting and fine-tuning aspects of interaction of the physical artifact and its features in use. Rather, the use scenario was adapted to features and characteristics of the physical representation that had been designed.

THE SECOND TRANSFORMATION UNIT

In the critiquing session a new group of students critiqued the design proposals presented by the design teams. The sessions started with one of the researchers instructing the design groups that they had 5 minutes to present their design proposal and their physical representation of it in a use scenario. They were encouraged to present their scenario by enacting it. The reviewers were instructed that they had 10 minutes to ask questions and discuss the design proposal.

The presentation of the bird group contained very little of a use scenario. The designers focused instead on the prototype's functionalities for sending and receiving messages and physical aspects of twittering. I.e., their focus was on how the bird was meant to communicate messages to a receiver through flapping of wings, tweeting, stomping its feet, nodding its head, etc. Their presentation included important aspects of physical twittering, however little focus was on who was communicating, what was communicated, in what context and why. I.e. there was little precision regarding users and use context in their presentation.

The first question posed by a reviewer shows the designers' lack of concrete use scenarios.

Reviewer1: *Is it limited to a certain number of users?*

Designer1: *We spoke of this…..[looks at other designer]..ermm...and I don´t know….since it is connected to…ermm…, that you make all the settings, that you have all the information somewhere else… it feels like lady Gaga which is the one perhaps most followed and tweeted is the one receiving the most responses could just as well use this as grandma that does not use it all that often*

Reviewer1:*..but can I as a user follow 500 persons..?*

Designer1: *ermm….well no follow…, that will be difficult…I don't know…*

Designer2: *No that, that… I do not consider it being a mass-communication thing, that is… friends own one…but sure…*

In the example above designer1 says they earlier spoke of the issue brought up by the reviewer but they did however not come to a decision or solution regarding the problem.

Immediately following the issue brought up above, one of the reviewers asks if old tweets can be checked after having turned the bird off and on again. The designers reply by saying that tapping the head of the bird turns it on and that the bird will indicate there are messages waiting to be listened to by flapping its wings. Another reviewer seems not to be fully satisfied by the answer and poses a follow up question:

Reviewer2: *…what happens if you have it turned off during the night, and turn it on again in the morning and everyone has been twittering a lot during the night, how are messages played up then, is everything presented as a big chunk of messages, all at once?"*

Designer2: *…well….ermm, ….this is solved by using the interface on a computer and there you can see all those that have tweeted through the interface, but sure this is a problem*

[…]

Designer1: *….you can make a setting on the computer that one only wants to*

listen to the last three or ten messages…

Reviewer3: *…so you mean you are dependent on a computer?*

Designer2: *a computer or a phone*

Designer1: *a phone or a computer, it depends on the interface…*

The reviewers here seem to question how messages were to be handled by the bird. The designers admit this to be a problem and the need to have to use a computer or mobile phone to handle messages seems to be a problem to the reviewers. By presenting specific use scenarios (what happens when I turn it off in the evening and on in the morning?) the reviewers investigate the bird and its functionalities. This becomes even more evident later on in the review, as witnessed by the following excerpt:

Reviewer2: *…I have a question, you want it to be connected through Bluetooth, WIFI, or something so you can carry it around with you, I do not use a handbag when I wander about in the city, how would I as a man carry it around with me, a bird talking, flapping etc.. [laughter]*

Reviewer3: *…in public, maybe you don't want others around you to hear or listen in to messages being tweeted, particularly when communicating with friends that can involve private stuff,… things that can be emotional…, or… you might be at a dinner, eating out and you don't want to receive messages right then,…*

Here the reviewers continue to put the bird to the test by exemplifying different use scenarios.

In the critiquing session we can see several examples of transformations that are made and these are often prompted by questions posed by the reviewers. The designers on several occasions admit that their proposal has its flaws and together with the reviewers discuss plausible solutions to these problems. As described earlier, the group has not come up with a coherent use scenario and this becomes evident when the reviewers point at different contexts of use. This forces the designer group to rethink their proposal, to

put it into a context of use, to further investigate aspects of interaction in that context and discuss alternative solutions.

In group2 one of the designers presented the design idea, the prototype and the use scenario (see figure 9). The scenario resembled the one they created previously and had a focus on the physical appearance of the prototype including its microphone, keyboard and loudspeaker. However, after the first designer came to a halt, other participants started to add features to the design idea such as the use of color to express emotions, the registering of movements and conductivity, the use of voice control as well as tactile features resembling those of a robotic hand. These added features were not included in the use scenario created in the preceding phase but rather have their origin in discussions they have had throughout the whole design process. We here observed that many of these other features that were previously discussed and seemingly discarded, now reappeared.

Figure 9:
Reviewers listening to designers in group2 presenting their design proposal, their prototype and use scenario.

Central to their way of handling questions and critique directed from the design reviewers was adding of additional features and functionalities. For example, one of the design reviewers asks a question about messages, and more specifically how messages are queued:

Reviewer: *How many messages... you could receive... are they queued, or? How... how... if I send you a message and Henrik does so simultaneously, are these messages then put in queue or do you receive everything at once?*

Designer1: *We were thinking that they were to be stored on a server or something similar*

Designer2: *Exactly*

Designer1: *So that you can access them at all times*

Designer2: *So you can choose to click next, there's a Next button*

Designer1: *Like an answering machine*

Designer2: *Yes, somewhat like that*

This excerpt shows how two designers answer to questions by adding functionalities that have not previously been discussed in the context of how to handle messages. The excerpt further shows how the design group seemingly has agreed on such a solution earlier on in their design work, however, our analysis of the design process shows no sign of having agreed on the solution presented. The example rather shows how the reviewers pressure the designers into continuing to investigate and develop the design proposal.

DISCUSSION AND CONCLUDING REMARKS

We adapted the concept of interactionary (Berkun, 2001) to fit within an educational context and analyzed these from the theoretical perspective of learning design sequences (Staffan Selander, 2008). In the following we 1) discuss the findings from the analysis in terms of interactionaries as a framework for interaction design teaching and learning, and interventions that interaction design teachers could make to orient and support student design work, and 2) discuss the framework of learning design sequences as an analytical tool to understand student design work.

PRACTICAL IMPLICATIONS: INTERVENTIONS TO SUPPORT STUDENT DESIGN WORK

One of the challenges of teaching interaction design concerns the need for students acquiring practical experience (Sas, 2006a; Strong et al., 1994). Admittedly, presenting students with design tasks in the format of inter-

actionaries does not provide practical experience of working in projects outside of academia but nevertheless provides students an opportunity to experience and practice on carrying out collaborative design work. In terms of teaching interaction design, the format can further aid teachers to understand more about interaction design processes and teaching of these, also acknowledged as a problem in teaching interaction design (Sas, 2006a). In terms of practical implications of supporting student design work and learning, we point at interventions below that design teachers can consider in order to support student design work, reflection and learning in contexts similar to the one described in this paper.

In the early phase of the design work (ideation phase), we made the observation that the groups swiftly arrived at and decided on a design idea before having tried out alternative and possibly competing ideas. This is not uncommon to student design work and therefore not exclusive to the performance of the student groups, or the format of interactionaries. However, the format invites and allows teachers to directly observe student design work and make interventions in context. An obvious intervention would be to point at not deciding on an idea until having tried out and valued alternative ideas. Another observation made was "feature creep", i.e., addition of unnecessary features into the design beyond the basic functionality resulting in over-complication (Jacob et al., 2008). The students added functionalities to their design proposals without considering those that they had already added and the overall objective of the interactive artifact. A teacher intervention could thus be to point at or question what would be the result of adding yet another functionality.

Furthermore, we made an observation concerning guiding concepts, i.e. design ideas, which strongly governed the discussions and choices of functionalities to add. One group was strongly influenced by the physical and communicative characteristics of birds whereas the other group seemed to be influenced by several ideas, namely, their ideas of a mechanical hand, a glove and contemporary mobile phones. In such a context a teacher could pay close attention to how students make use of a guiding concept so as not to abandon innovative ideas, to coach and assist students in delimiting and focusing the design idea. Another lesson to learn from this is to encourage students to make use of the physical representations that are created to investigate characteristics of the design idea and aspects of interaction.

Our observations further showed that when the students were directly asked about aspects of interaction during their presentations, more focused discussions about interaction followed. Especially, when the design group had a comprehensible use scenario, discussions more readily focused on aspects of interaction. If more elaborated discussions about interaction is what a teacher seeks for, a teacher should point at the importance of working with use scenarios.

USING LEARNING DESIGN SEQUENCES TO UNDERSTAND STUDENT DESIGN WORK

When the guiding concept is strong (as in group1) it becomes a strong frame for adjacent forms of ideas and also works as resistance against inconsistent ideas. A guiding concept in terms of a use scenario on the other hand may work as a frame for delimiting consistency in terms of how the participants may envision future use. The guiding concepts thus to different degrees seem to challenge the students to continue transforming their idea.

The learning design sequence framework was appropriate for analyzing interactionaries; the interactionaries include the formative and summative phases emphasized by the framework. The framework further uses the concepts of mode and media. Modes denote modes of expressions while media denotes representational states in some physical form. As described above, the students make use of several forms of expressions in the form of enactments and gestures during their design work. Some of these are formed into physical representations and then work as a vehicle for further exploring as well as transforming the ideas in terms of new expressions. The framework emphasizes this interplay between the more transient states and the more solid states in the learning process. The playfulness of the modes of expressions sometimes does not make it into the physical representational state but is still of high importance in order for the investigation of the design space to proceed. Many good ideas expressed during the interactionaries were neither manifested in the physical representations nor presented in the final use scenarios. Traditionally, teachers only assess final representations but the representation is only a partial answer to the assignment. In academia this is often dealt with by requiring the students to verbally or in written text articulate design considerations and choices and what is left out. Not so infrequently, such rationales are written in retrospect rather

than during a design project. The format of interactionaries, allow teachers to directly observe design considerations as they are formulated in real time and to discuss these with the participants. Likewise, students are presented with the possibility to articulate and elaborate their design choices immediately after the fact rather than retrospectively in a written report.

Other concepts central in the framework of learning design sequences is formation and transformation. The formation is a constructive part of combining modes and media, while transformation is a form of change driven by interpretation and structures enabled by the media. In contemporary interaction design there is a trend towards emphasizing having a dialogue with the material (Schön & Bennett, 1996; Tholander., Normark, & Rossitto., 2012). As the present study shows much of the ideation work is documented into a physical representation. However, many promising ideas do not make it into the physical representations and the work on the physical representations may even distract and redirect the designers' focus from the primary task to details of the physical design.

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