Using Interaction Qualities as an Approach to Conduct Interaction Design Research

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Abstract: This research aims to explore how to use interaction qualities to guide interaction design research by combining functional, experience and technology approaches in design. In an interactive prototyping course a number of interactive prototypes were built in which interaction qualities are explored and demonstrated. From designing, building and testing these prototypes, we learned to conduct interaction design research by using interaction qualities explicitly as criteria to guide and constrain the design process. We found that interaction qualities connect to all three design approaches, and they can be introduced into design education by using a well-known operation principle as a given for a research project.

Key words: Interaction Qualities, Interaction Design, Design Research, Interactive Prototyping

1. Introduction

In interaction design education, we often see that design students either go for (i) a functional approach by creating product forms and running usability tests, (ii) an experience approach by applying storyboarding and role-playing techniques, or (iii) a technology approach by sticking together sensors, actuators and displays and seeing what comes out. Each of these approaches has its strength and weaknesses. The functional approach has its strength that it typically provides measurable success, it has a drawback that it takes a traditional and limited area of improvement [3,11]. The experience approach has its strength that it connects deeply to the user, but runs the risk of being very limited and quite often we see that students do not get beyond concepts described in words, in associated images or in scenarios [2,10]. The technology approach has its strength that it keeps updated to the state-of-the-art development technologies, but also runs the risk that the first sensor picked and the first program written are where the design ends up [8], because the designers fixate on incremental tuning of the prototype and neglect looking for totally new directions.

We envisage using interaction qualities as design guidance that can help designers to make a link between functional design, experiential interactions and the use of interactive technology. Interaction qualities are also called experiential qualities [5], denoting 'the experienced attributes of artifacts-in-use' [4,9], which means they only come about through actively engaging with a product, system or service. In a recent prototyping design course in our institute, a number of research prototypes were built in which interaction qualities were explored. We let students explore different sensors and actuators. They also had to focus on the experiential interaction qualities instead of programming details. We gave the students constraints that it had to be a working demo and to be engaging for people. Our research objective has been to explore how to use interaction qualities to guide

interaction design research by pulling functional, experience and technology approaches together. This is an interesting challenge that presents itself to educators, researchers, designers and developers.

2. Method

Interactive Technology Design is a course in the Design for Interaction master programme at the Faculty of Industrial Design Engineering at the Delft University of Technology [1]. The course aims to equip students with design theory while gaining practical experience in the development of interactive prototypes, which utilize potentials of embedded interactive technology in products in terms of enriching user experience. In the spring semesters of 2010, 2011 and 2012, we mentored and worked with 50 students, who worked in teams of five on three design briefs concerning new ways of interacting and working. Six key interaction qualities (instant, playful, expressive, collaborative, responsive and flexible) identified in our previous research [6,7] were explored in this design course in 2011 and 2012 and were used as guidance to combine functional, experience and technology approaches. Table 1 describes the qualities with specific examples. The concept and prototype development involved a total of five iterations. The first two iterations focused on exploring conceptual possibilities and building initial prototypes by hacking existing products. The third iteration aimed to nut-crack the hardest technological problems and further develop the concept to a mature level. The fourth iteration involved users, while the last iteration targeted on integrating user comments to finalize the prototypes.

Table 1. Definition and examples of the six interaction qualities

Quality	Definition	Example
Instant	The interaction is experienced as immediate, spontaneous and on the spot	Drag files into Dropbox to store and share timely
Playful	The interaction is experienced as engaging, enjoyable and challenging	Pull down a list to update on an iPhone
Collaborative	The interaction is experienced as supportive, unifying and shared	Game with virtual friends online
Expressive	The interaction is experienced as open, free and animated	Shake an iPhone to shuffle songs
Responsive	The interaction is experienced as alert, quick and reactive	Tap to wake up a device alertly
Flexible	The interaction is experienced as adaptable, accommodating and adjustable	Play game with a Wii controller instead of a mouse

3. Research Framework

Figure 1 shows our research framework, which distinguishes three design approaches: functional approach, experience approach and technology approach. On the intersections of these three approaches lie the interaction qualities we want to understand, explore and use. In three iterations of the Interactive Technology Design courses, we tried to gain insights and experiences into building the coherence of keeping together of function, experience and technology by making use of interaction qualities. In the sections below, we present our design research activities on the three approaches and their intersections. This paper concludes with our design insights and discussions for continuing the research.

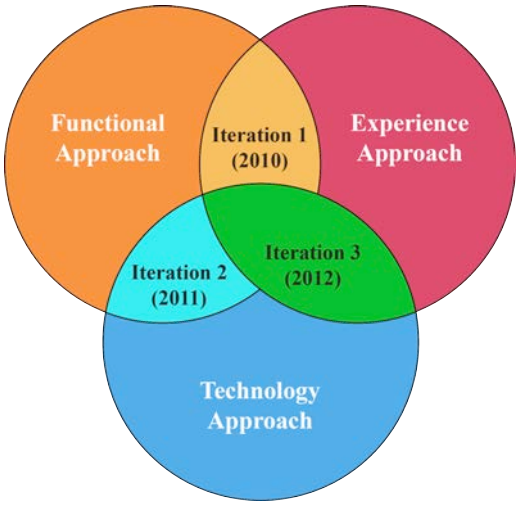

Figure.1 Research framework

4. Exploring Work Context

In the first iteration in this course in 2010, the interaction qualities were not yet available from our research. We focused on function and experience. The design brief stated that each student team had to design an interactive tangible product that visualizes Exact's corporate identity and engages their employees and visitors in a collaborative activity. Exact is a developer of business software solutions. Exact is interested in learning about future office workers and implementing proper designs in their own services and products. The student teams had to build experiential prototypes, going through several rounds of conceptualizing and improvement.

4.1 One of Us

One of Us is an interactive video installation (see Figure 2) that aims to introduce the corporate identity in a natural, collaborative and innovative way by the people who work at Exact. Using the metaphor of the family portrait, the employees who play an important role in the movie, react according to the visitors' actions. Three tangible objects, a telephone, a lamp and a table, are metaphors for communication, inspiration and collaboration. When a person gets close to the installation, the phone starts to ring until the visitor answers the call. From the other side of the line, a virtual employee tells about her/his own working experience at Exact. Visitors are invited to switch on the lamp to play a movie, which presents the international network of the company all over the world. A virtual employee invites visitors to take a seat. The employee starts to explain the corporate identity.

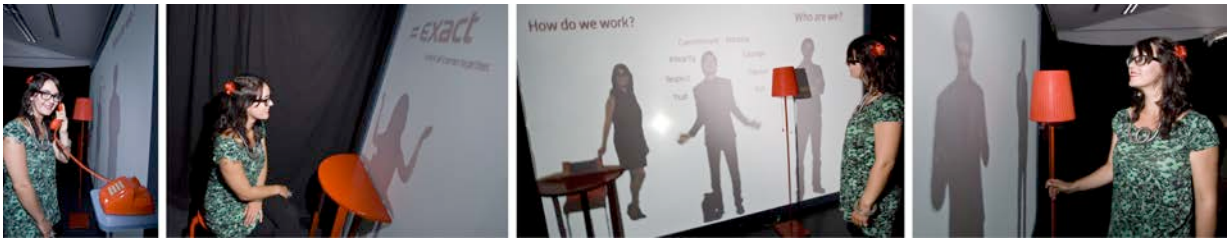

Figure.2 User tests of One of Us. A video scenario is available at: http://youtu.be/jzbIdzjZcQg

4.2 Spyglass

Spyglass is a mediator between Exact and people (see Figure 3). The visitors and the employees can experience the company building with augmented reality. The Spyglass breaks the reality into a second layer of information, which people can interact with. While exploring the building through the Spyglass, users can see and listen to the

names of the departments with the employees, the frequently updated company blog with (voice) comments, the menu of the day in the canteen and other information.

Figure.3 User tests of Spyglass. A video scenario is available at: http://youtu.be/YTzuzkzgVKs

4.3 Message in a Bottle

Message in a Bottle is a communication system that stands on a long table for the lunch area in the company building (see Figure 4). This system improves social cohesion in the company. The light from the bottles invites people to sit at coupled places. In this way people would sit randomly next to each other, without gaps in between. People can speak to each other, even if they sit far apart, through speaking to the bottles. Glowing light indicates the microphone and speakers are on. This happens on two spots randomly chosen by the system (the system has to recognize the spots which are occupied). So, the person on one spot is able to hear and speak to the person on the other spot without any initiative effort. If a person does not want to be part of the conversation, he or she has a chance to turn it off.

Figure.4 The setup, field trial and scenarios of Message in a Bottle. A video scenario is available at: http://youtu.be/rC39jMjCqkU

4.4 Design Insights

Three interactive prototypes were built, each demonstrating new ways of working and communicating in a work context. All prototypes have functions, which are to visualize corporate identity by engaging employees and visitors in collaborative activities. All prototypes are experiential because user-product interactions are required to operate them. Technology was widely explored in this iteration. The students practiced prototyping skills (i.e. programming) and the researchers gained teaching experiences. The results were more design visions made into prototypes than feasible designs. Although moderate results were achieved, the lack of design guidance and criteria made the results difficult to be compared and summarized. Studies on design guidance had to be done before running the course in the next iteration in 2011.

5. Exploring Interaction Qualities in a Work Context

In the second iteration in this course in 2011, understanding of the work context and the interaction qualities were available from our research [6]. We tried to use interaction qualities as guiding and focused on function and technology. The design brief stated that each student team had to focus on a pair of instant, playful and expressive

interaction qualities, to create a specific scenario in a work context and to explore how these qualities could stimulate or facilitate new ways of working. To do so, they had to build experiential prototypes, going through several rounds of conceptualizing and improvement.

5.1 DropBall

DropBall is an explorative concept for fun and easy file transfer (see Figure 5). The design has playful and expressive interaction qualities. With DropBall users can transfer files by throwing a physical and familiar object: a stress ball. Colleagues are enabled to share digital files and links on this ball through an easy user interface. A squeeze in the ball triggers a desktop application to pop up, and while squeezing the ball the user can drag and drop files into the digital representation of the ball. Pick out a colleague you would like to share the information with, and throw the ball towards him/her. Once received, the colleague only needs to squeeze the ball to make the files appear on screen, and clear the data ready for next use.

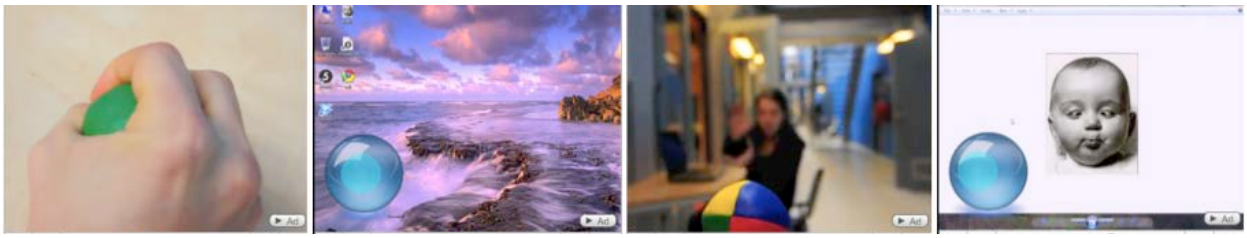

Figure.5 The use scenario of DropBall. A video scenario is available at: http://youtu.be/rNpRz9jZ5Ec

5.2 Hermès

Hermès is aimed at unobtrusively asking a colleague whether he is available for a short, unscheduled meeting (see Figure 6). The design has instant and playful interaction qualities. The sender can select a receiver from a personalized list of favorites by turning a selection ring. The ball that is pushed into Hermès conveys the request. At the colleague's Hermès, the ball pops up. The sender is displayed in the list of favorites on the selection ring. The colleague chooses to accept or reject the message. Consequently, Hermès gives positive or negative feedback to the sender. It also registers absence of the recipient and gives negative feedback in that case.

Figure.6 The design and field trial of Hermès. A video scenario is available at: http://youtu.be/dKZZiLbxuqI

5.3 Permission Lamp

Permission Lamp is a desk lamp that assists colleagues to receive and respond to meeting requests (see Figure 7). The design has instant and expressive interaction qualities. When a request is received, a green light shines towards the user to notify him/her. The lamp provides the user with three ways to respond: 1) Postponing the request by pushing the shade (head) of the lamp away, making the light dim. After a while the shade turns back towards the user, indicating that it still needs attention. 2) Rejecting the request by pushing the shade of the lamp down to the table, making the light turn red first, then turn off. The lamp finally turns back to its neutral position with the green color. 3) Accepting the request by stroking/petting the shade of the lamp. The light turns green and drops the shade submissively, followed by the lamp turning back to its neutral position with the green color.

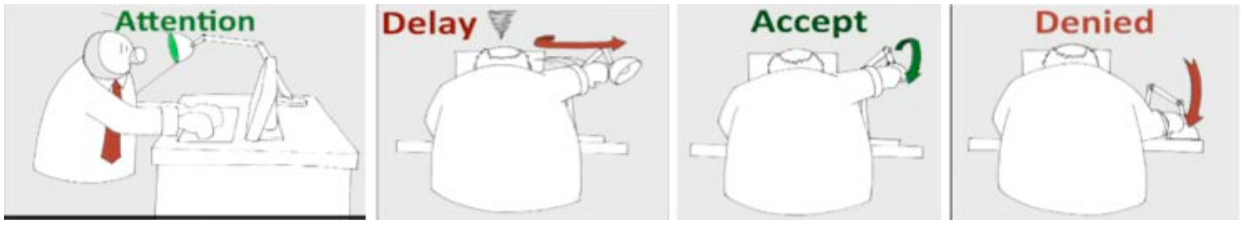

Figure.7 The user interactions of Permission Lamp. A video scenario is available at: http://youtu.be/qkqKjWhxy3Y

5.4 Design Insights

Three interactive prototypes were built, each demonstrating a pair of interaction qualities and novel user-product interactions, which could enable, support, and affect new ways of working. Through user tests with office workers in a real company context, we found that the office workers agreed that the concepts were more experiential to interact with compared with the existing tools in office work. Further modifications were made to the prototypes, i.e. the DropBall group focused on personal files sharing instead of more generic file sharing, because the throwing action is considered as a more personal and playful way for sharing by the users. Based on the evaluation of the demonstrators, a number of preliminary design guidelines can be foreseen to drive the development of future office applications, for example:

- Future ways of working have to enable instant and expressive ways of user input interaction, such as squeeze, blow and stroke.
- Any novel user interaction has to express a playful interaction quality, and has to be easily recognized and performed.
- Future office applications have to support collaborative interactions and features, e.g., sharing and co-editing files simultaneously and in a collaborative way.

6. Exploring Interaction Qualities

In the third iteration in this course in 2012, we focused with a special emphasis on education for the learning experience of the students to try to make the interaction qualities stand out. Aim of the assignment was not to make 'the best product', but to focus on improving the interaction qualities for a given principle. The classical computer game Pong was chosen as a vehicle to build interactive prototypes. It has a sufficiently simple required input, so broad explorations with technology are possible. The basic principles of Pong are easy, robust and iconic, which helps in focusing on optimizing and tuning the interaction qualities rather thinking up (and developing) a totally new principle. Moreover, the iconic quality helps in attracting visitors and in explaining the setup and goal in seconds. We focused on designing interactive user inputs, instead of on screen interfaces. Each student team had to focus on a pair of the six interaction qualities, to use Pong to create a specific scenario and to explore user interactions. To do so, they had to build experiential prototypes, going through several rounds of conceptualizing and improvement.

6.1 Space Ship

Players fly two ships on a 2D map with obstacles (see Figure 8). The aim is to eliminate the opponent by taking the initiative to crash into him. The design has playful and expressive interaction qualities. A balancing board with thrust control was designed and built to fly one ship. Leaning left on the board turns the ship left and vice

versa. Pulling a rope thrusts it upward. There is also an option for multiple players to join this side. These players get respectively a flame-thrower and a gravity gun to pick up and throw virtual objects. A Kinect is used to fly the other ship. The Kinect lets the player fly the ship around the map in a free style. (Note: This group crossed the boundary of using the classical Pong and created their own).

Figure.8 The use scenario and field trial of Space Ship. A video scenario is available at: http:// youtu.be/pg6faM35pjY

6.2 Pada

Pada is an audio game with bodily movement as input and music as output (see Figure 9). The design has expressive and responsive interaction qualities. By using headphones and spatial sound, two players hear the music moving through the environment. In order to pass the music to each other and get the game going, they have to intercept the music before it has passed them. Players tilt their bodies and/or heads left and right to catch the position where music goes, in the mean time Pada measures their positions. These interactions involve whole body and convey guiding information.

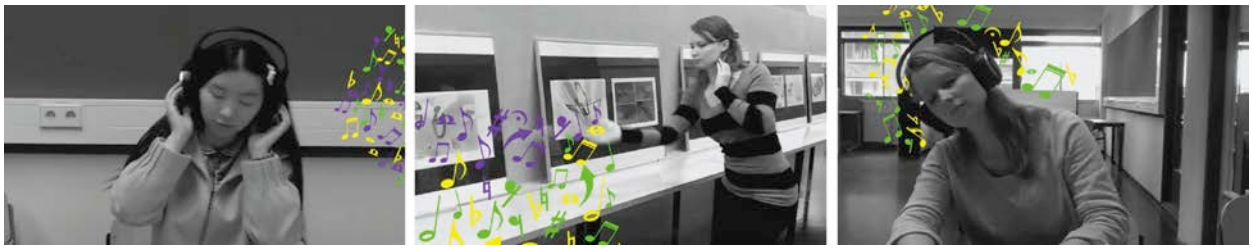

Figure.9 The use scenario of Pada. A video scenario is available at: http:// youtu.be/qnFJt8FWOqk

6.3 Jump & Balance

The game is projected on the floor, which allows controlling the paddles to become a physical activity (see Figure 10). The design has collaborative and flexible interaction qualities. Four players are challenged to use special features in order to influence their opponents in a negative way. Controlling the paddles needs collaboration between two players as a team. One team controls the paddle by jumping on air pillows. The paddle reacts on the movements of the sensor by using air pressure. The other team controls the paddle by using a large balancing board. The paddle reacts on the height difference of the board.

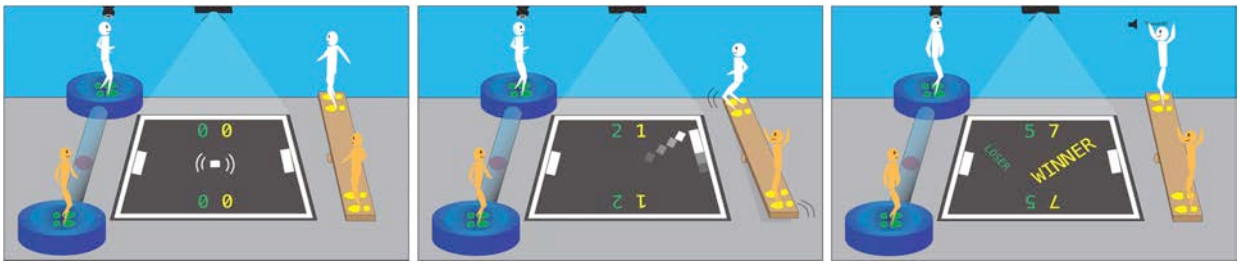

Figure.10 The use scenario of Jump & Balance. A video scenario is available at: http://youtu.be/JjYmTnKW5xs

6.4 Pirate Ship

Two pirate ships represent the two paddles in the Pong game (see Figure 11). The design has instant and collaborative interaction qualities. There are four set of user inputs: 1) pull and release handle to attack the opponent, 2) dodge onto the platform to avoid cannonballs, 3) pump air to repair the shortened paddle (note: the paddle shortens when hit and also as time goes by), and 4) steer a steering wheel to move the paddle.

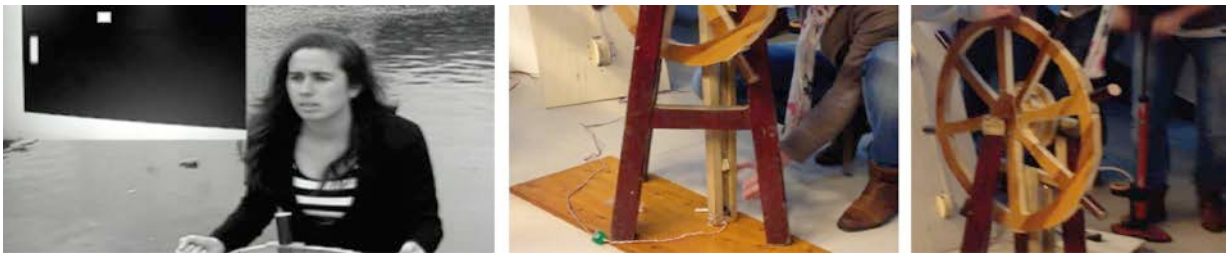

Figure.11 The design and use scenario of Pirate Ship. A video scenario is available at: http://youtu.be/xqUoXZK6oXI

6.5 Design Insights

Four interactive prototypes on Pong were built. Each demonstrates a pair of interaction qualities. We used sensor technologies to make user inputs more physical and interactive, e.g. blowing and steering. We have chosen to drive design by choosing an interaction quality as aim, and then explore the use of function, experience and technology to support the chosen quality. The function, experience and technology depend on the chosen quality, rather than the other way around. With the interaction qualities expressed and optimized, functional, experience and technology approaches can be pulled together. Interaction qualities together as a set can guide interaction design research with technologies in other research domains and situations, such as the office, the home and the hospital.

7. Discussions

Within this work in the first iteration in this course in 2010, we focused on using function, technology and work context with experience of asking students to do all the things and that around the company identity, which has both function and experience role for the company, Exact. And the technology was broadly explored. There was some demand from the course to feature interactivity and sensor technologies. For the second iteration in 2011, we found that the interaction qualities can be picked up, but in the learning experience of the students, the functional, experience and technology approaches were still pulled very hard. It was difficult as the first exercise for the students to achieve all those goals together. Therefore in the third iteration in 2012, we focused on making the interaction qualities stand out. The benefit is that we gave interaction qualities in the design brief and we dressed down the complexity of function, experience and technology to a very well known and basic structure, Pong. So that we could give the students more freedom to focus their more attention on achieving the qualities rather than chasing a gimmick or going into developing a new view of the office and then not being able to achieve a testable result. Pong was chosen because it would have simple, basic and rich game characteristics. It was proven to be so during our exercise. Within that narrow space of interactions, the center of our research framework forced to engage deeply with the interactions among function, experience and technology through exploring and using the interaction qualities.

8. Conclusions

From the experience gained in three iterations of the design course, two valuable things are brought out: The first is bringing in interaction qualities explicitly as criteria to guide and constrain the design process. The advantage of using interaction qualities approach is that they connect to all three design approaches together. The second is in educating this approach by using a well-known operation principle and design concept (i.e. the game 'Pong') as a given for research projects, so that the quality of different design solutions can be compared on the interaction qualities specifically. Our next step is to further explore and use interaction qualities in interaction design research courses and projects.

9. Acknowledgement

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6. References

[1] Aprile, W. and van der Helm, A. (2011) *Interactive Technology Design at the Delft University of Technology - a Course about How to Design Interactive Products*, In Proceedings of E&PDE 2011.

[2] Boess, S., Saakes, D. and Hummels, C. (2007) *When is Role Playing Experiential?: Case Studies*, In Proceedings of TEI 2007, ACM Press, pp 279-282.

[3] Chiang, C. W. and Tomimatsu, K. (2011) *Interaction Design Teaching Method Design*, In Proceedings HCII 2011, Springer-Verlag, pp 45-53.

[4] Frens, J. W. (2006) *Designing for rich interaction: Integrating form, interaction and function*, PhD dissertation, Eindhoven University of Technology, the Netherlands.

[5] Hult, L. (2003) *Public information services: A study of use qualities in Internet-based encyclopedias*, PhD dissertation, Linköping University, Sweden.

[6] Liu, W., Stappers, P. J., Pasman, G. and Taal-Fokker, J. (2011) *Supporting Generation Y Interactions: Challenges for Office Work*, In Proceedings of CSCW 2011, ACM Press, pp 669-672.

[7] Liu, W., Stappers, P.J., Pasman, G. and Taal-Fokker, J. (2012) Making the Office Catch Up: Comparing Generation Y Interactions at Home and Work, In Proceedings DIS 2012. ACM Press, pp 697-700.

[8] Martin, F. and Roehr, K. E. (2010) *A General Education Course in Tangible Interaction Design*, In Proceedings of TEI 2010, ACM Press, pp 185-188.

[9] Rullo, A. (2008) *The Soft Qualities of Interaction*, ACM Transactions on Computer-Human Interaction, vol. 15, no. 4.

[10] Sleeswijk Visser, F., Stappers, P. J. van der Lugt, R., and Sanders, EB-N. (2005) *Contextmapping: Experiences from Practice*, Journal of Codesign, vol. 1, no. 2, pp 119-149.

[11] Thomassen, A. and Ozcan, O. (2010) *Standardizing Interaction Design Education*, Journal of Computers & Education, vol. 54, no. 4, pp 849-855.