

Mattias Arvola | Henrik Artman

Mattias Arvola | mattias.arvola@sh.se

Henrik Artman | artman@kth.se

## Studio life: The construction of digital design competence

### Abstract

This paper analyses how interaction designers act and think in two different studio settings in order to understand what potential each setting presents for the development of digital design competence. We first observed interaction design students working in a design studio and then in a computer augmented interactive space. In the studio, the students oscillated continuously between individual and cooperative work, while in the interactive space, the work was focused on shared displays. The results describe how students collaborate to develop digital design competence, which not only includes competence in using digital media, but also competence in envisioning and articulating someone else's future use of digital media.

#### KEYWORDS

Interaction Design • Interactive Spaces • Studio Learning • Digital Competence

### Introduction

Learning to design is as much a social process as it is a process of becoming skilled in sketching and innovation. However, design in the computer science curriculum, especially Human-Computer Interaction (HCI), is often based on heuristics, guidelines, procedures and theoretical concepts (e.g. Hewett, Baecker, Card, Carey, Gasen, Mantei, Perlman, Strong & Verplank, 1996). Only those students who are able to transform these abstract notions into persuasive communicative practices will be successful in a professional context. In an effort to facilitate this transformation, education in human-computer interaction design has during the last ten years, to a greater extent than before, utilised studio-based approaches (e.g. Arvola, 2005; Bleviss, Lim, Stolterman, Vetting-Wolf, & Sato, 2007; Docherty & Brown, 2000; Holmlid & Arvola, 2007; Holmlid & Ericsson, 1998; Messeter, 2005). In order to understand the implications of studio-based learning, and especially

what implications different designs of the studios have, we studied students working in a project room which was designed specifically for design teaching, as well as the students working in a computer augmented interactive space. Our research question was primarily to investigate in what way the two different settings would afford collaborative work constellations and secondarily to format hypotheses for what consequences this might have in developing digital design competence.

In this paper learning in interaction design will be discussed in terms of digital competence and digital design competence. ‘Digital competence’ is here defined as the ability to confidently and critically *use* digital media to fulfil certain socially relevant purposes (Buckingham, 2006). ‘Digital design competence’ will at this stage be defined as the ability to confidently and critically *design* digital media *for other people’s confident and critical use* of that media in their fulfilment of certain socially relevant purposes. Digital competence is hence also requisite for digital design competence. When using the word ‘design competence’ we draw upon Holmlid’s and Arvola’s (2007) competence framework, which they used to develop a curriculum and define progression between studio courses in a master programme in design. In summary, their framework states that a Master in Design should be able to:

- Develop and present original and creative visions and concepts.
- Use design methods in systematic inquiries, evaluations and sketching.
- Manage various tools and materials.
- Take users’ and other actors’ perspectives.
- Be versatile and work in different contexts.
- Use design theory and do design research.
- Continuously develop one’s competence.

The students in this study have primarily been fostered to be competent in the above. This study presents firstly a field-study of how the students work in their “home” studio and secondly how they interact in a computer-augmented interactive space.

### Studio-Based Learning in Design

Practically no research has investigated what students do in interaction design studios to develop their design competence, and how they utilise different tools and structural resources in that endeavour. There are, however, quite a lot of studies on architectural design studios (e.g. Schön, 1987; Sachs, 1999; Uluoglu, 2000; Shaffer, 2007) as well as other studios, for example, graphic design studios (Fleming, 1998).

The tradition of studio learning as a way of educating designers is over a century old and it involves open-ended projects similar to actual practice, a number of structured conversations (critique sessions or “crits”), and some kind of public presentation of the

work at the end of the project (Shaffer, 2007). The idea is that learning is constructed within the projects by the student and in meetings between the student and teacher or between student and student. The formal and informal critique sessions open up a zone of proximal development (Vygotsky, 1978) where students progressively internalise processes which they initially can only do when assisted by others.

Sketching and visual experimentation is fundamental to design (Buxton, 2007). By drawing a solution the consequences of a particular decision or “move” can be appreciated. In design, drawing is conceived as a process of trying out design moves and discovering their consequences and not only a means for presentation (Schön, 1987). It is a threshold for many students to realise this and some students continue for a long time to regard drawing and sketching as a means for communication of already-made ideas. By working with many different media for representing an idea, different aspects of it are highlighted and new ideas and problems emerge (Shaffer, 2007). Articulating a design by sketching as well as fortifying the sketch by verbal articulation can be seen as a way to demystify design practice and in a sense it is the essence of learning to design (Schön, 1987).

Quite often, students report that they get stuck (Arvola, 2005; Sachs, 1999). To get unstuck they seek help and try to see the design in a new way. The eyes of fellow students and of the teachers are invaluable in these situations (Sachs, 1999). Thus collaboration between fellow students is of utmost importance, either as a way to articulate design decisions, to get unstuck, or just to get new perspectives on the future use of the designed artefact.

Shaffer (2007) has compared a studio to traditional learning in labs and has noted a number of differences summarised below:

- In the studio, students had their own workspaces; in science labs students share workspaces, and spend quite some time setting up projects and cleaning up afterwards.
- In the studio, students met for large blocks of time, and since they had their own workspaces, they could also work in the studio outside scheduled times; in labs students have access to social and material resources for a limited period.
- Outside experts played a central and recurring role in the studio; labs often only involve teacher and students.
- A wide range of media for the development and representation of problem solutions were central in the studio; labs focus on only a few representational tools and forms.
- In the studio, feedback was generative; in labs, much of the feedback students receive is summative.

Shaffer highlights differences between learning in labs and learning in studios, and this makes it reasonable to suspect that different studio environments can structure the students’ collaborative learning differently. We therefore invited students from a traditional

design studio to work in a computer-augmented interactive space. Below we first give a brief account of computer augmented interactive spaces and their possible implications for design collaboration, before returning to our particular study.

## Interactive Spaces and Computer Augmented Collaboration

During the same period of time as the development of studio-based curricula in interaction design, there have been several attempts at constructing computer augmented interactive spaces, aiming at supporting and enhancing creative collaboration. The point of departure for interactive spaces is embedding displays and computers in a physical space.

An early interactive space for creative collaboration was Groupsystems, which was an electronic meeting room for the purpose of understanding, evaluating and improving decision making (Nunamaker, Dennis, Valacich, Vogel & George, 1991). Groupsystems utilised microcomputers with rather limited display space, which gave restricted opportunities for experimenting with private and public windows and multi-user interfaces (Stefik, Foster, Bobrow, Kahn, Lanning & Suchman, 1987). The objective of Groupsystems was to improve decision performance and task completion by the group and all individuals, by avoiding errors and premature or superficial decisions, and considering more alternatives and more information.

Dolphin (Streitz, Geißler, Haake & Hol, 1994) was a system that utilized a Liveboard (later commercialized by Smart Technologies as Smartboard) and personal computers to create both private and public workspaces. It combined two interesting characteristics in relation to sociable use: public workspace on a smartboard with public and private workspaces on personal workstations, and it allowed parallel manipulation of public workspaces. Dolphin was also used in the Ocean-lab, in which Streitz, Rexroth, Holmer (1997) ran a series of experiments that showed that groups that had both private and public workspaces produced products that were rated to have higher quality. In particular, they produced significantly more ideas than groups that only had a public workspace and groups that only had networked private workstations. Groups that only had a public workspace were less active. The combination of private and public workspaces allowed group members to work in parallel and they used the public display as a focus for discussion and coordination. The ideas from Ocean-lab have eventually evolved into the i-Land environment where interactive systems, building and furniture are tightly integrated (Streitz, Tandler, Müller-Tomfelde & Konomi, 2001).

Geisler, Rogers and Tobin (1999) report work on collaborative systems in the Design Conference Room and the Collaborative Classroom designed at Rensselaer Polytechnic Institute. They suggest that multidisciplinary collaboration is a situation that, to a high degree, is characterised by mixed-focus between individual work and group work. The basic idea behind their “public collaborative system” is to interweave conversation in phy-

sical space with information exchange in the virtual space by (a) lines of view to systems, (b) lines of sight between people, and (c) lines of control between the users' private systems and the public systems.

It is our impression that most of these attempts at creating interactive spaces for creative collaboration have been guided more by what can be done than by what should be done. If we want to make an interaction design studio into an interactive space, we need to acknowledge that learning in design studios has a certain history and rationale, which has seldom been accounted for in the design of these interactive spaces. This study aims to inform such progression.

### The Design Studio

At Linköping University, studio-based learning in interaction design has been practiced since 1997. The design studio is an open office workplace with space for eight students as well some workspaces intended for cooperative tasks (Figures 1 and 2). Some years, there have also been two studios. Each student has his/her own workspace with a personal computer and can organise and decorate it according to individual taste and purpose. The studio is also equipped with a large common whiteboard as well as a shared PC with projector.



Figure 1. Students working in the studio.

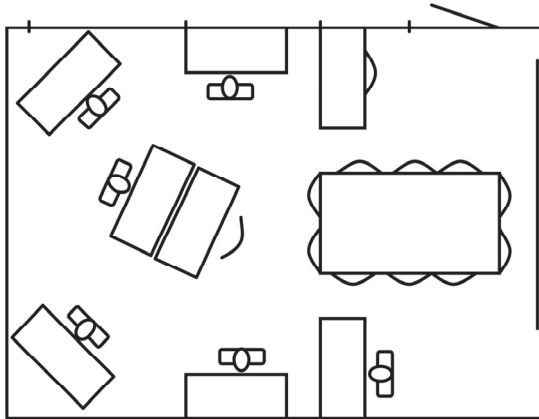


Figure 2. Layout of the studio.

### The iLounge

At the Royal Institute of Technology in Kista, there is an interactive space called the iLounge, depicted in Figure 3 (Sundholm, Artman & Ramberg, 2004; Artman, Ramberg, Sundholm & Cerratto-Pargman, 2005). It was designed and built for the purpose of supporting co-located collaborative work. It is used both as a learning facility and as an experimental research facility. Two large touch-sensitive displays (Smartboards) are built into a wall (see Figures 3 and 4). In front of this wall is a table with a horizontally embedded plasma screen, also touch-sensitive. This interactive table is large enough for up to eight people to sit around it. In one corner of the room a smaller table and three chairs are placed in front of a wall-mounted plasma display, enabling part of the group to work separately. The room has a wireless network and contains laptop computers with a wireless LAN card. The keyboards and mice in the room are also wireless, using Bluetooth. The studio is equipped with commercial PC-operative systems with additional software that allows the users to open documents on any of the computers (Tipple<sup>1</sup>) in the room as well as to use the same pointing devices at any other computer screen (Multibrowse, Pointright and iClipboard<sup>2</sup>). Finally, the iLounge contains high-quality audio and video equipment that can be used for videoconferences, or during user studies.



Figure 3. Work in the iLounge.

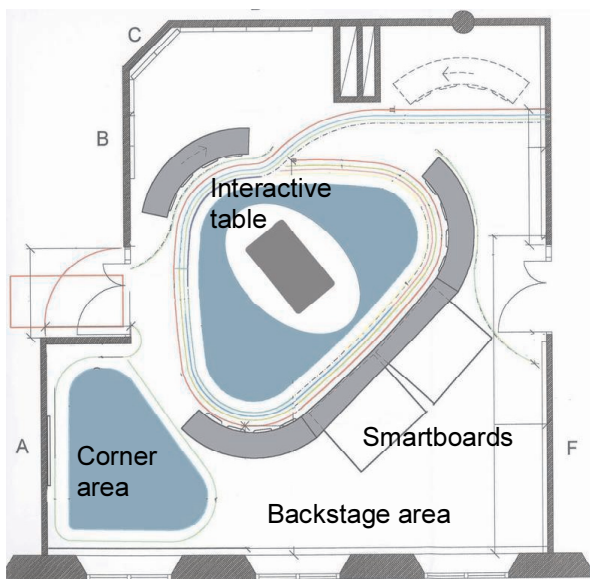


Figure 4. Plan of the room. The working areas are shadowed.

## Method

Through field studies and video recordings we examine interactions between students within the design studio, which has been set up primarily for individual educational purposes and the interactive space has been designed to facilitate information sharing and visualisation for a team of students working on a collaborative design task. The two contexts are compared as to what extent they admit different forms of reflection and creativity, peer review and resumption of interrupted tasks, as well as collaborative tasks. The study was not designed to compare exactly the same processes in the two settings, but rather to study how students from the Linköping studio made use of the different environment encountered at the iLounge. The study was focused on the interactive design processes between the peers rather than the results of what they as peers or individuals accomplish, that is, only the interactive processes are exemplified and the end result is not assessed.

### *Observation in the Design Studio*

A field study of the interaction design studio at Linköping University was conducted. The specific focus was on episodes where students used resources individually and then jointly, before returning to individual use. Thirty hours were spent on observing the work of the students and the teachers. Interviews were conducted as the opportunity arose during the observation and they were triggered by episodes that took place. Field notes were continuously taken, and three hours of video footage was recorded during a design review. The observer had previously acted as a teacher in the studio and prior to that had also been a student in a similar setting. The field notes were analysed using thematic analysis (Ely, 1991; Kvale, 1996). The first step was to become familiar with the material. The second step was to find meaningful episodes in the text where participants expressed their view on the work, or where properties of the studio environment were particularly important for their work. The third step was to concentrate these episodes into short phrases that expressed a central theme from the perspective of the participants, and this theme was noted in the margin. The fourth step was to categorise every episode in the field notes according to the identified themes (creativity, reflection, inspiration, flow, concentration, critique, autonomy, participation, spontaneity and politeness). As categories were accumulated the fifth step was to thematically organise categories in the higher-level aggregated categories Individual Work and Cooperative Work. Finally the seventh step was to put together the material for presentation based on the themes.

### *Observation in the iLounge*

The particular workshop, which was analysed for this paper, is part of a series of workshops with students performing and learning interaction design in the iLounge. In



total, the empirical material is encompassed by approximately 5 hours of video recordings made using 4 cameras.

Four interaction design master's students from the studio in Linköping, two male and two female, were invited to iLounge. They all knew each other well, having taken the same courses for four years. The two female students were given a design brief asking them to design an interactive space to be used for studio classes. The two male students were given a brief asking them to design a drawing tool for an interactive digital whiteboard. The briefs thus pointed towards design solutions in the direction of the iLounge they were to visit and experience. The design briefs were not chosen to be compared, but rather chosen to make the students reflect on tools for collaborative design settings and present these two different designs to each other in a critique session. Our idea was that they were to seriously consider how they would like such an environment to be structured, and thus come up with ideas about how the technology of iLounge could be used in a design studio. Our main interest, however, was to understand if and how the iLounge would change their way of working.

The participants had worked individually on their designs before coming to the iLounge. During the first hour at the iLounge, an introduction to the interactive space was given. They then had thirty minutes to synthesise their individual design work with the work of the other design student who had been given the same brief. They then ran a one-hour presentation and critique session. After these sessions we conducted a one-hour evaluation of the iLounge studio and discussed their thoughts on working there. We recorded their work using both audio and video from 4 cameras. No interventions were made, except during the evaluation, which was facilitated.

All verbal utterances and gestures were transcribed in our native language (Swedish), and only after analysis did we translate them into English. The analysis followed a similar thematic analysis as in the design studio.

## Work in the Design Studio

In the interaction design studio that was studied, six to eight students worked. They had their own PCs and their own desks, which were covered with sketches and personal items. Two design teachers sat in private offices in the same corridor, and they could, if they wished, see the students through the large windows between the corridor and the studio. Within the studio the students could see and hear each other and cooperate at the whiteboard or the shared large table, or at someone's desk. The whiteboard was also used for projection from the shared PC, which had extra accessories such as CD-writer, drawing tablet and scanner. Near the whiteboard and the shared table there were also bookshelves with books on design and human-computer interaction.

### ***Cooperative Work***

Some design assignments in the studio involved group work and others were individual. The individual assignments had, however, also vital elements of participation. During interviews and during design work, the students often emphasised the need for inspiration, which often came from other students in the studio.

Seeing the work of others lead not only to a chance of obtaining inspiration, but also an opportunity to critically reflect on their own projects, and they had a chance to talk about their work and perhaps re-frame their design problem. These are participatory processes where content is coordinated between two or more students. In order for the students to perform the coordination of content they also needed to coordinate the process; they needed to be aware of what the other was doing in order to know when they could interrupt. The following is an example from the field notes of coordination of the process:

Jack leans back and looks at the screen. Changes position and continues to write. "How's it going? I'm like done now." Turns to John and walks over to his desk.

This excerpt shows how Jack declared that he was ready for a new round of joint work after working by himself for some time. The awareness of what others were doing was important for another reason as well. A student could provide serendipitous input to someone else's work if he or she walked by another student's desk and saw that he or she was working on a specific project from the papers that lay on the desk. The students were even aware that others in the studio had specific systems for how they arranged their desks. The following excerpt from the field notes is taken from a conversation with several of the students:

You don't mess around with others' stuff. But you can see what is there. Some are more individualised... made into one's own (Swedish: *inbodd*). Sarah, for instance, has a representation of a workflow on the desk and a categorisation of different documents. But you can touch others' work on their desks when you work together on a project, but you cannot mess it up. Everything has to be put back the way it was. And then you can see if people are there or not; if the screen is turned on, or if there is a jacket hanging on the chair. And you can hear what people talk about. Then you can cut in and say something and meddle in their business. That is good. (From a conversation with interaction design students)

When someone got stuck, a common strategy was to ask someone to look at one's work. Whenever this happened the situations turned from individual to group work:

Jack: I have emphasised a lot... How they should look at ah. Look at this.  
((they walk over to Jack's computer and John sits down in Jack's chair))

Jack: Change it if you want to. I added a link, but it was hard to find the company link.  
((silence))

John: ((reading)) Yeah, but this is all right. This looks cool.

Jack: Right.

Students worked together on projects by the common table, or pinned up things on the walls in the studio, and they often presented things to each other discussing different solutions. As part of participating in studio learning, the students needed to share, help each other, coordinate, critique, keep track of things and inspire each other. The students learned to master the design rationale by engaging in negotiations and criticism of the design.

### ***Individual Work***

Here follows an excerpt from the field notes in the studio case where Jack and John worked on a group assignment:

Jack rolls his office chair over to his desk when they have divided the work. Then they work in silence. After a while Jack leans back and stares up at the ceiling. He changes position, and continues to write.

Jack: How is it going? I'm like done now. ((walks over to John and they discuss)) Eh, we'll do it like this then?

John: Yeah.

Jack: Should they do that exactly?

John: Eh, but... I've changed some minor things.

In this episode Jack and John worked individually when they needed concentration and focus. They divided the work and went to their private desks. When the different parts were completed they worked jointly again. Before this episode they sat at the shared table, sketching together on a large sheet of paper and before that they worked individually, trying to figure out how to approach the problem. Their group assignment had accordingly large portions of individual work.

The students and the teachers could easily see what others were working on by glancing at the sketches and the printed screen shots on the desks. The possibility to see what the others were working on provided a basis for unplanned interaction and chat about their work. This created an opportunity for help and inspiration. After these shorter periods of group work they went back to individual work again. The private and personalised desks seemed to enable the students to break off collaboration and return to their own

desks. Still, as the private desks are within a few metres of each other it is easy for other students and teachers to either intervene in any of their peers' work or for any of the peers to implicitly or explicitly ask for help and inspiration.

The oscillation between cooperative and individual work seems to be important for developing competence in using the technology and developing an understanding for its opportunities; that is, digital competence. Interaction with peers was also assumed to be important in order to develop the necessary mastery of envisioning the future use situation and the digital competence of the actors pwho would be using the designed system. In order to be a competent designer of digital media one needs to master both aspects – that is, to have both digital competence and digital design competence.

### Work in the iLounge

Working in the iLounge usually meant that quite some time needed for setting up the technology and logging in before starting business. The work also had to be scheduled since the meeting room had to be booked in advance. This also meant that the students had to put everything into order every time they had used the room. It was thus not possible to personalise the iLounge in the same way as the design studio.

In contrast to the design studio, the interactive space focused most interaction towards collective representations, such as interactive smartboards and other shared displays, as seen in Figure 5.



Figure 5. Students working in the iLounge.

As much as collective representations seemed to support cooperative work, they seemed to make the design process single dimensional and they did not afford individual work and reflection as seen in the much more personalised design studio presented above.

As the design students had been assigned to figuring out how to make use of the iLounge technology in a traditional design studio, we need to mention something about their ideas. Much of their effort was aimed at finding ways for allowing the smartboards to be manipulated by multiple users at the same time, so that people could do simultaneous work individually. An example of how they generated ideas and structured their work can be seen in the following excerpt:

Daniel: But I think it's, what I think is a bit difficult about this is that we absolutely cannot work at the same time. Think of if I were to like "*But check this out, then we cannot have that there...*"

Christian: Exactly. If we do that then I would come and say, "*but this should be here*", but you will say "*no it should be here.*"

Daniel: "*But, we do like this?*".. hang on... wait a moment..

Christian: Then I want to at the same time, and want to move these...

Daniel: Exactly...or you want to draw... Say you want to draw down in the corner...

Christian: There you have the advantage with the whiteboard. Okay, then you sketch there and I sketch here...

By engaging in role-play they enacted a possible future use situation. They expressed a developing understanding in their verbal dialogue and visual articulations, and thereby developed an assessment of the digital competence the imagined user would possess. Most of the time in the iLounge, work was cooperative or collective in this manner. It is mainly through the students' articulation we can infer their need to connect the smartboards with their personal computers in order to support movement between individual and collaborative work. In their own actual work in the iLounge they almost entirely worked collectively. By role-playing around the shared smartboard they continuously drove the discussion of the future use in a collective manner. This role-play oscillated between their actual use of the current resources and their understanding of what would be needed in future, developed through their own enactment of being the users. This enactment articulated the collectively developing digital design competence.

The other two designers also focused on issues at the intersection between individual and collaborative work. Anna and Barbara had two basic ideas: that users needed plenty of space for sketches and that they needed space for both individual and collective activi-

ties. They were quite surprised that their sketches coincided. They tried to create a highly flexible space that could be reconfigured by moving around furniture, cameras and curtains. Smartboards were also mobile and could be tilted to work both when standing upright and as an interactive table (for details see Arvola and Artman, 2006). Again, the designers articulated the importance of oscillation between individual and cooperative work, but did not actually oscillate themselves during their design processes. Instead they stayed quite close together during the whole process, engaging in joint enactment. Based upon both these accounts, we think that the setup of the iLounge was affording more collective work and in a sense obstructing more individual work.

## Discussion

The social interaction in the Linköping design studio was organised in such a way that each and every individual was able to oscillate between individual and cooperative work. In contrast, the iLounge focused much interaction towards collective representations, such as the interactive smartboards and other shared displays. As much as collective representations seem to support cooperative work and the development of digital design competence (in terms of learning to envision other people's use of digital media), they seem to make the design process single-dimensional and they do not afford individual work and reflection. Our analysis suggests that unplanned interaction and participation seem to be critical when designing spaces for fruitful interaction. Such aspects are easily omitted in spaces, like the iLounge, that are designed with large shared screens and a shared workspace. As we have seen in a former study (Sundholm et al, 2004), one way for the students to get more privacy is to go to another room. To break up collaboration may however be difficult in groups with strong cohesion or when the task is strongly based on collective work, since people then may want to take part in what is going on. This means that an oscillation between individual creative thinking and more collective dissemination of ideas seldom comes into play. Having a private workspace seems to make this transition between individual and collaborative work less problematic.

The results of this explorative case study are work hypotheses, and do not directly guide pedagogical work and processes of interaction design. Even though the examples presented here at face value are representative for work the students did, they might be an artefact of these specific students or for that matter our perspective. However, Sundholm et al (2004) and Artman et al. (2005) have made findings pointing in the same direction.

Shaffer (2007) noted a number of differences between a design studio and traditional science classrooms. In our study we can corroborate some of his observations, but we would also like to add some differences between a design studio and computer augmented interactive spaces:

In the studio, students met for large blocks of time, and they could also work in the studio outside scheduled times; in the iLounge the students had to book the room and hence only had access to the social and material resources for a limited period.

In the studio, students had their own workspaces; in the iLounge, students spent quite some time setting up projects and cleaning up afterwards.

A wide range of media for development and representation of problem solutions were central in the studio; the iLounge focused on the shared digital displays, which provided fewer representational tools and forms.

The two settings, the Linköping design studio and the iLounge, afforded different possibilities for collaboration. From our descriptive analysis we have found that the iLounge was affording more collective work. This in turn, prevented the students from taking a step back and reflecting and distancing themselves from the shared design work. In the Linköping design studio every individual had a personal workspace, which they returned to as soon as collaborative activities were over – that is a kind of home – while the iLounge was mainly a shared space where it took an effort to break away from the collaborative activity.

We wish to stress that digital competence is necessary for becoming a skilled interaction designer. However, digital competence is seldom enough. Studio-based learning seems to enable and afford social interaction and a non-obstructive zone of proximal development within which the interaction designers also can assess and articulate future users' digital competence – another necessary aspect of digital design competence. However, studio-based learning should not only focus on social encounters between peers, but also enable individual contemplation. Careful design of interactive spaces in design studios may facilitate this. In the next section we present some design implications that we think are of great importance when designing interactive studio spaces.

### ***Design Implications***

If we were to use iLounge technology in studio-based interaction design education a number of issues would need to be addressed. The first would be to have a permanent workplace for every student, where they could come back to work finding their workplace organised the way they are used to and could start up work where they left off.

The second issue would be to make sure that private workspaces were situated in close proximity to public workspaces, to facilitate spontaneous interaction and easy movement between public and private work. We wish to stress the importance of being around others, both peers and teachers.

The physical space as well as the digital space must be sharable and visible to the others in the studio. This implies a need for easy-to-use mechanisms for putting things up for public display in the physical space. Shared displays as well as notice boards are important. Putting up a digital object on the wall should be as easy as putting up a physical sketch,

and giving a digital object to a peer should be as easy as handing over a piece of paper. The current technologies, although not assessed here, do not really fulfil such measures.

A system for joint work (smartboards and digital tables) must be up and running all the time. When someone enters the room they should be able to use the technologies for collaborative tasks. It will not support unplanned and spontaneous interaction if time is required to set it up. This points towards a lightweight technical framework. Keeping it simple is the key.

In a design studio, there is a need for working with a multitude of representational means, including paper, physical models and computers. Developing mixed media spaces for design studios would be an interesting topic for future research.

### *Learning the Talk of Interaction Design*

This paper has moved between technology, art/design and social sciences. As in many cross-disciplinary projects we are never truly at home anywhere. The title of the paper is a paraphrase of Bruno Latour's and Steve Woolgar's book "Laboratory Life: The Construction of Scientific Facts" (Latour & Woolgar, 1986). We do not make such groundbreaking claims as they did, nor do we to any higher degree make use of their arguments. Instead, we paraphrase their title to indicate a shared goal. They wanted to demystify science; it is our ongoing research aim to demystify some aspects of design. We are not there yet, but this paper is one step in that direction.

As Latour and Woolgar argued, science is not about discovering facts, but rather about socially constructing facts. Similarly, interaction design is not only about having technical skills or digital competence to create original and creative products, but it is also about learning the communicative practices of design work by mastering the articulation of envisioned future use. Unplanned and spontaneous inspiration and critique, as well as planned critique sessions that generate new ideas rather than constituting a summative evaluation, are key ingredients in developing digital design competence where designers constructively and continuously judge, re-frame, develop and refine their design. Such encounters requires both physical resources in terms of various representational media as well as a didactic awareness of facilitating an oscillation between in-depth individual work and collaborative interactions where each individual's perspective is elaborated collectively.

Using a studio-based curriculum, interaction design can be taught as a competence centred on communication as much as on technical skill. This is where students learn to construct digital design competence through articulating design. As this study suggests, one should be careful when designing contextual resources, as students will adapt their learning strategies to a given environment. How to design studio-life that facilitates oscillation between individual and collaborative learning in interaction design is of utmost importance for future research in digital design competence.



## Noter

- 1 Tipple is developed by the FUSE group, Stockholm University/ Royal Institute of Technology, and can be downloaded at <http://www.dsv.su.se/fuse/downloads.htm>
- 2 Multibrowse, Pointright and iClipboard are part of the iWork package and are developed by the Interactive Workspaces at Stanford University. The iWork services can be downloaded at <http://iwork.stanford.edu/download.shtml>.

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