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Interaction design, pedagogical practice, and emancipation

In November 2007, the Research platform M3 [man medium machine]/the School of Communication, Technology & Design at Södertörn University College arranged, in collaboration with the ITU, Oslo University, a two-day workshop on the theme Interaction Design in Pedagogical Practice. There were 15 position papers submitted to the workshop, representing 15 different universities from four countries. Out of these, we now have the privilege to publish four of them in this special issue of the Nordic Journal of Digital Literacy, together with a debate article. They are, in their own respect, modest witnesses, of the need for this dialogue between interaction design and pedagogical practice.

Interaction design, understood as the practice of shaping conditions for interaction by means of digital media, is having an increased influence on pedagogical practice. Digital media hold great promise in relation to human learning and development in a wide range of areas, and pedagogical practice is in extensive need of an update (to use tech-jargon) in order to meet the needs and expectations of the New Millennium Learners (Pedró, 2007).

One example of this merging is the recommendations on key competences for lifelong learning from the European Parliament and Council, where digital competence is proposed as one of eight key competences. As for what is considered "essential knowledge, skills and attitudes" it is stated that:

> Digital competence requires a sound understanding and knowledge of the nature, role and opportunities of IST [Information Society Technology] in everyday contexts: in personal and social life as well as at work. This includes main computer applications such as word processing, spreadsheets, databases, information storage and management, and an understanding of the opportunities and potential risks of the Internet and communication via electronic media

> (e-mail, network tools) for work, leisure, information sharing and collaborative networking, learning and research. Individuals should also understand how IST can support creativity and innovation, and be aware of issues around the validity and reliability of information available and of the legal and ethical principles involved in the interactive use of IST.
>
> European Commission, 2006

Interaction design will most certainly become increasingly important in relation to pedagogical practices. At the most obvious level, it is clearly the case that behind every interactive application there is some kind of explicit or implicit interaction design work, involving what users can and cannot do with the application. In relation to this, the Gibsonian concept of affordance (Norman, 1988; Gaver, 1991) is often brought up, suggesting how human action can be directed by the semiotic cues presented to her. At a more complex level, the design of any given artefact used by humans will in one way or other influence her conceptualization of not just the artefact, but also the surrounding world as well as herself. In educational settings, digital media are all the more important building blocks in the process of constructing personal as well as social knowledge. This is one major reason why digital competence is a key competence, since digital media change the conditions for learning. By using and appropriating digital media the user shapes new possibilities for herself as a citizen. It is therefore of utmost importance to understand the relationship between the design of interactive digital media and human action and development. The need, therefore, to go beyond our pre-conceptions about learning and knowledge, implies a need for a transformation of theoretical understanding, helping us to challenge what we (think we) know, and to be open to what we do not know.

The meeting between interaction design and pedagogical practice raises a range of important questions. What common themes and problems can be jointly addressed in interaction design and pedagogical practice? What are the core differences between the fields? How do we deal with the usage of a similar vocabulary, while we do not share a common discourse that creates mutual understanding of the concepts? Such a critical discussion is, of course, a long process, hopefully attracting a large number of practitioners and scholars. The workshop and this special issue highlight a number of important questions and provide significant contributions to this process. After introducing the articles and what we see as their primary contributions in relation to this discussion, we will raise a couple of related questions that we think are in need of further elaboration at the intersection of interaction design and pedagogical practice: in what ways do the two fields characterize themselves as being emancipating (a core concept in both fields), and in what ways are heteronormative power structures recognized in interaction design and pedagogical practice? We will initially define emancipation as the process of becoming free from controlling influences or structures of, for example, traditional hierarchies or

beliefs. Heteronormativity, an abbreviated version of normative heterosexuality, is the assumption that heterosexuality and heterosexual norms are universal or at least the only acceptable conditions. Variations from this standard for identity are marginalized. This includes variations from the normative gender categories male and female and associated roles in society.

Introduction to the articles

In the first of the articles, Arvola and Artman set out to understand the potential of the studio as a pedagogical learning environment. Based on studies of how interaction designers act and think in two different studio settings, they discuss the learning process in relation to cooperative and individual work. The article raises important questions about how to develop creative learning environments, a question of relevance not just for design educations, but for any education. Furthermore, it contains an important theoretical and methodological question, although it is not specifically addressed: How should we study the process of learning? What *is* this thing that we call learning? How is it manifested? What tools do we need to register "learning"?

Karlström, Cerratto-Pargman and Knutsson discuss the relationship between digital literacy and design, using the example of tools for second language learning. The article illustrates that we tend to not just rely on digital technologies (like grammar checkers), but also on how actors become involved in the shaping of our thinking (which an activity theorist most likely would agree with). This is not the same, we think, as the notion of technological determinism. Still, it is we as humans who construct meaning. However, this meaning is influenced by the tools we use. This underscores the fact that the development of digital literacy relies on a critical approach towards not only the tools we use, but also their implications in work, school and everyday life.

In her article, Svabo concentrates on a specific group of technology users: children at a museum. After reading the article, the question of how findings like these translates to children as a whole remains. Just as with the other articles, this calls attention to the fact that in order to deepen the knowledge about what could be called "use heterogeneity", the vague category "user/s" needs to be reflected on. Perhaps the most striking part of Svabo's article, however, is the attention paid not to the digital media of the museum, nor to the exhibition as such, but to a pamphlet. This pamphlet becomes a means of mediation between the user/visitor and the exhibition/museum. Again, we see how artefacts affect the meaning-making process, as well as our actions; hence, artefacts are creators of meaning, in need of interaction designers with not just technical fluency or creative and critical skills, but also methodological as well as theoretical breadth *and* depth. Or, if that is too much to ask of a single person, how can we incorporate all this into one design process?

Tholander and Fernaeus formulate four challenges for the design of digital tools that aim to support children's possibilities for expressing themselves in everyday casual situations. In their emancipatory ambitions of a practical design, they make us aware of the fact that much technology is designed for work or learning, i.e. a notion of "the useful" or what is profitable. Once again this is an illustration of how the words we use tend to direct not just our attention, but also our values and opinions. As with any other field, interaction design practice has its canon constructing its paradigm. Hence, the challenge presented by Tholander and Fernaeus is also a methodological and theoretical one, pointing at the need to challenge ourselves and our pre-conceptions. The ambition of the workshop, and now this special issue, has been to address this very point; to challenge by way of dialogue. Curiosity and open-mindedness are of key importance in such a dialogue.

The question about studio-based learning, as addressed by Arvola and Artman, is further developed by McGee in the concluding debate article. This issue is particularly relevant to our own practice since the School of Communication, Technology and Design, to which the editors of this special issue belong, is, at the time of writing, moving to new facilities and needs to address how to make best use of them in its pedagogical practice. Without doubt, it is highly important to seriously, as well as continuously, discuss and extend these learning environments in order to best support the students in their development. McGee uses a theorist-practitioner approach when discussing interactive digital media research studios. He also directs attention to the burning question of higher education: What experiences are important for fostering critical and reflective thinking? What do the students need to know, and what do they need to master? What knowledge, be it theoretical or practical, or any combination of the two, is relevant at the break of the 21st century?

The articles in this special issue are to varying degrees expressions of reflective practice (Schön, 1993; 1997), and both interaction design and pedagogical practice are fields where reflection and discussion are highly valued. One important area to further develop our discussion is the power structures of the societal context where not just interaction design and pedagogical practice meet, but also where both find their "users".

Artefacts, design and human action

The debate about the contingent benefits of external tool use in the pedagogic endeavour has a long history. Plato's dialogue in Phaedrus is an often-cited example, where Socrates argues that the written word "will create forgetfulness in the learners' souls" as "they will trust to the external written characters and not remember of themselves."[1] Media will, in short, alter the way we learn as well as what we learn. Furthermore, Socrates argues in this dialogue with Phaedrus, which is of interest in relation to the notion of digital compe-

tence, that mastering the tools of an art only means that you know the basics. To actually understand and practice the art you need to learn its purpose and value in society. Or, in other words, develop a critical approach.

As different kinds of digital artefacts become more and more influential in pedagogical practice, it is important to discuss the intersection of the design of digital artefacts and pedagogical practice. We will do this, by focusing on the emancipating ambitions of the two practices. What does emancipation mean in the two fields? In what way are they emancipating? As an illustration of the concept of emancipation in the two practices, we will focus on the ways in which heteronormative power structures are recognized. Again, let us stress that we ask questions, rather than provide answers. The examples we use are chosen for the sake of argument. They are not necessarily fully representative of the fields, neither are we critical of the referred works: our aim here is to start a discussion based on our experience. It is likely that we may miss important as well as interesting contributions already made in these fields. Nevertheless, we will argue that there is a need for further and deeper discussion in this area.

The use of tools in human learning practices did not of course arise with digital technology. Tools for painting, and later on writing tools, have been around for more than 30,000 years; one of the earliest examples that we know of are the drawings of horses from the Chauvet Cave in France. These early paintings are examples of how the use of tools helps humans to organize their lived experiences, and also how information can be separated from time and place. Of course, the cave paintings are bound to a certain place. But we need little fantasy to see how similar symbols are being painted on pieces of wood or skin. Our argument is that the media we use transform our understanding of not just the world around us, but also our understanding of ourselves and our capacities. The abacus as well as the alphabet – perhaps the most remarkable tools ever used – have now been around for about 5,000 years. Humans using tools as "extensions of our consciousness" (McLuhan, 1964) is hence nothing new, regardless of whether or not they are physical or mental (psychological) (Vygotsky, 1978; Wertsch, 1991). This is not to say that tools do not differ in their character. Digital media *is*, in its essence, something else than analogue media. Its *meaning*, however, is still a human construct.

If we jump to more modern times, one of the first uses of (what was to become) the computer in education was the simulated training of aircraft pilots during the 2nd World War (Hernwall, 1998). This kind of machine-based training was initially developed by Sidney Pressey in the 1920s, with the aim of improving the learning outcome of students. In 1954 Skinner presented his first teaching machine, following the ideas of behaviourism. This can be said to be the precursor of computer-assisted instruction in the 1980s, basically building on operant conditioning. During the 1960s, the teaching machine, together with programmed instructions, turned out to be highly popular, although it never became as widespread as its advocates argued (and hoped) for. This gap between utopian

expectations and factual profits seems to be a recurrent trend in respect of media use in education. In the 1980s Papert (1980) argued for how programming an icon (the Logo "turtle") to move on the screen could support children's arithmetic understanding, while also making the school more relevant. Later on, Papert (1993) was a bit more resigned, stating that the school was more or less a lost cause. And this was before what was to be named "the Internet revolution". In the late 1990s, computer games became another captivating rabbit-hole, magically endorsing learning, as playing is fun. These were followed up by web 2.0 and the idea that we as users collaborate in order to create content, share information, and so on.

Even though we still see little of the marvels of the proponents, contemporary digital media become more and more important in formal education, and also more and more widespread. There are of course several reasons for this. The technology becoming more accessible in terms of cost and usability is most likely an important reason for this shift in understanding of the qualities of digital technology, together with a deepened understanding of how to make use of it. Today, the use of computer technology to enhance people's possibilities for learning is commonplace. This can be seen, for example, in the form of distance education, e-learning, multimedia visualisation tools, etc. An initial observation regarding the use of technology for learning – from intelligent tutoring systems to e-learning applications – is that there are, implicitly or explicitly, assumptions made about how humans learn and how technology should be designed to match the learning process. Accordingly, this has led to the fact that the dominating psychological theories of learning during different time periods have been paralleled by trends on how to design technology for learning. But, as we will see below, modern theories about the conditions for human learning and development are not limited to the psychological or cognitive aspects, and they have never been. One field of particular interest in relation to the theme of this article concerns the power structures present in any learning situation. The most obvious power structure is where there is at least one person (assumed to be) in possession of knowledge, and at least one who is not. Furthermore, the design of the learning environment, gender relations, economic recourses, ethnicity, and so on, all have a critical influence on the outcome of any learning process. But the importance of power structures such as these is often neglected in the practice of interaction design, which is a bit strange, as the user is presented as being central in interaction design theory and practice.

Berg and Lie rhetorically ask if technological artefacts have gender (Berg & Lie, 1995). Of course they do, as they are man(!)-made. It is primarily men who work with technology; technology is historically (culturally) understood as being masculine. Technologies used by women (or any other marginalized group/category) are understood as being something else than technology (i.e. telephones, sewing machines, microwave ovens), and the notion of the user being male (a white, heterosexual, middle-aged, middle class, westerner) is seldom questioned. This negligence of gender being present in any artefact

tends to confirm gender stereotypes and "build on stereotypical gender differences" (Faulkner & Lie, 2007, p. 169), as with the pink Sony PS2 game console. Who is it for? What kinds of games can be played on a pink PS2 – and does this differ between girls and boys? Perhaps a more multi-dimensional example might be Volvo's Your Concept Car (YCC), entirely designed by women for women. To what extent does the Your Concept Car question gender stereotypes – and to what extent does it reinforce them? Are the YCC and the pink PS2 examples of designs that "do gender" – or do they create new opportunities for gender identities?

Are these kinds of critical questions present in interaction design processes? And, if so, are they important questions in interaction design processes? We argue that they are important, and we further argue that they are, to a large extent, absent today. Issues of ethnicity, class and age of equal importance in this respect. Some of these categories are addressed in terms of economic concerns and target groups, but they are seldom addressed in a critical sense. All of these should be regarded as important analytical categories in relation to the common political-ideological vision that exists in many western societies today of an IT-society for all.

Pedagogical practice and power structures

Turning to the pedagogical practice and the rather comprehensive research on formal and in-formal learning settings, there is a deep as well as widespread knowledge, that power structures are present in almost every learning situation. Just a few examples: studies on gender and speech acts show that men/boys speak more, in other ways and have a different understanding of gender positions in the conversation space, and these patterns are also repeated in online communities (Herring, 2001). Another example of these power structures is that school tends to give power to children from the middle classes, whereas children from the working classes tend to be marginalized. This is largely an effect of *how* the teacher acts (the one with power), and *what* competences are considered important. It has also been suggested that one reason for digital media not being accepted in the school environment, is that it is associated with popular culture. The school on the other hand, the argument goes, should stand for the values embraced by cultural heritage, the fine arts, and not least, printed books. Besides gender and class, attention has been paid to ethnicity as an analytical category in relation to formal education, and also to the possibilities of digital media and information and communication technology in this respect.

The outcome of an activity, where conditions are designed (regardless of whether it is designed by an interaction designer or a teacher), is deeply dependent on heteronormative power structures. Experience tell us that power structures are important within pedagogical practice, and also that they are appreciated as such within both pedagogical the-

ory and practice. The field of interaction design may acknowledge the existence of such power structures, but seldom addresses them directly. Here, intersectionalist theory helps us to pose critical questions about power and power structures. The intersectionalist perspective (Lykke, 2003; McCall, 2005; de los Reyes & Mulinari, 2005) assumes that there are several intersecting power structures at play. These different power structures do not form additive categories, but there is a dynamic interaction between different asymmetric power dimensions (Lykke, 2003). Accordingly, users cannot be said to be a group. Taking gender, class, ethnicity and nationality into consideration, the group "users" become as elusive as "Europeans" or "students" (see also Bannon, 1991). The hierarchical power structures are not fixed entities. Just as they are challenged, they change depending on time and space. Looking at how Norwegian tweens (aged 10 to 12) use information and communication technology in their everyday practice, Hertzberg Kaare (et al., 2007) found that "[n]ew communication technologies offer good conditions for developing children's peer culture, while the family-oriented culture has become weakened" (ibid, p. 621). Somewhat ironically, parents aiming to strengthen parental control often buy the technology. How these tweens use communication technologies illustrates not only that hierarchical power structures are dynamic and flexible, but also that the appropriation of information and communication technology has important consequences for power hierarchies, much in line with Donna Haraway's seminal cyborg manifesto (Haraway, 1985).

Before coming back to power structures and emancipation from them, we wish to clarify our conceptualisation of the notions of interaction design and pedagogical practice a bit further, as well as the intersection between the two.

Intersecting interaction design and pedagogical practice

The two fields, interaction design and pedagogical practice, are both design-oriented fields of practice. Whereas interaction design is the practice where interactive digital media products and services are created, the pedagogical practice is about designing learning environments. The former field focuses on the interaction with and through the product or service, while the latter has its primary interest in the learning subject. Pedagogic research (rather than pedagogic practice) is a social science and hence, according to Habermas' view of social science, emancipatory in its ambitions. Pedagogics, or educology as the scientific discipline has also been named (Papert, 1988; Qvarsell, 2000; Hernwall, 2007), studies the conditions for learning, development and socialisation, in formal as well as in information learning settings. The focus of pedagogical practice is on optimizing these conditions for learning, given the uniqueness of the situation. Using a similar vocabulary, interaction design focuses on the shaping of conditions for interaction by means of digital products and services. A bit more extensively, we define interaction de-

sign as the shaping of conditions for humans' interaction with, through and by means of a designed (often digital) artefact (Arvola, 2005).

Theories of the processes of learning are often roughly categorized into three historical traditions (Gardner, 1985; Säljö, 2000; Wilson & Myers, 2000), firstly behaviourism (1900–1960s), secondly information processing psychology (1950–today), and thirdly socio-cultural or situated theories of learning (1970–today). These traditions all differ in their views on human thinking and knowledge. This is reflected in the different approaches to how learning technology should be designed from those theories. Koschmann (1996) describes the development of four different paradigms for the design of technology for learning, the first being Computer Assisted Instruction (CAI), which is based on behaviourism and information process psychology. The second paradigm involves so-called Intelligent Tutoring Systems (ITS), with roots in Artificial Intelligence and information processing psychology. The role of the tutor in this tradition is to ensure that the student receives and understands a well-defined piece of knowledge. The third paradigm, the Logo-as-Latin approach, views knowledge as constructed by the individual learners themselves and not as something that can be defined and inscribed in a system and then transferred to the learner. This constructivist perspective has led researchers to try to build tools that allow students to construct their own models of their personal knowledge. The fourth and most recent paradigm is Computer-Supported Collaborative Learning (CSCL) and the related field of Interaction Design and Children (IDC). In these perspectives, socially-oriented approaches to learning and human action are brought to the fore, thus suggesting that in designing and studying technology for learning, it is the social aspects of the situation under consideration that should be taken as primary. From these approaches, technology for learning may take a number of different forms. It is problematic to view a particular application as being an example of a particular research tradition. Instead technology for learning and interaction must always be characterized within its context of use.

Interestingly, the notion of design also seems to be becoming more popular in educology and the pedagogical practice. "Design for Learning" (Rostvall & Selander, 2008) is the name of an anthology (in Swedish), discussing what they name a "design perspective", formulating questions on how, in what way, and with what means knowledge takes shape. In this perspective, the representational form is significant for how the subject will come to understand objects, information, and knowledge. And also, how the subject will design her own understanding of what is to be learned. The socio-historical context, the learner and her abilities, as well as the tools (in the broad sense) used, are all important in not just *what* will be learned, but also *how* this learning will unfold. Hence, for us, learning as well as interaction can be understood as taking place in the intersection between the individual and her resources, and the external environment (with persons, history, material objects, representational forms, traditions and norms, etc.). Tools and media, especially

digital tools and media, have a great influence on our learning and understanding, as they augment us and form prostheses that transform our embodied and mindful construction of our world (e.g. Clark, 2003; McLuhan, 1964).

Creating opportunities

Let us now return to the notion of emancipation. Habermas (1981) concluded that emancipation should be the essential interest for the social sciences – which includes both pedagogics/educology and (at least partly) interaction design. Habermas argued that knowledge is gained through transformed consciousness, based on communicative action. For this transformation of perspective to take place, reflection is central as it might lead to self-emancipation. Emancipation is, in other words, reflection based on rationality, furthering life possibilities.

Even though one can easily criticise the practice of formal education for being out-of-date, non-relevant and even marginalising, the ambition of emancipation is a core value within pedagogical practice, perhaps best illustrated in the tradition of Freire (1970) and the liberation of the oppressed. A cornerstone for the democratic school is the assumption that every individual should be respected as a unique individual. This tradition can be seen in, for example, the Swedish curriculum from 1994 (Lpf 94) for the non-compulsory school system (Skolverket, 2006), where the following is stated as a fundamental value:

> The task of the school is to encourage all pupils to discover their own uniqueness as individuals and thereby actively participate in social life by giving of their best in responsible freedom.
>
> Skolverket, 2006, p. 3

With knowledge of the presence of hierarchical power structures in pedagogical practice such as those mentioned above, the Lpf 94 formulation sounds visionary (or perhaps self-righteous). With digital media now entering pedagogical practice, the situation is becoming all the more problematic as the field of pedagogical practice seldom has neither the tradition nor the tools to undertake a critical evaluation of the benefits and/or shortcomings of any particular digital artefact. The field of pedagogical practice is thus in the hands of the field of interaction designers or other IT professionals who create the digital learning tools. This situation is being further reinforced by the ambivalence of pedagogical/educological research in relation to tools supporting learning; accepted if they are traditional tools such as pen and paper or mathematical formula, but more problematic if they are computer software, Wikipedia or a mobile phone. One could say that the potential emancipatory qualities of digital media are overshadowed by the traditions of pedagogical theory in general, and especially the notion of the learning *subject*. It is almost as

if digital media is conceived as obstructing human emancipation. This reflects a hard-wired idea about technological determinism, in terms of technology leading to negative consequences.

Interaction design, on the other hand, has a more positive relation to the potential of digital media. Iversen (et al., 2004) illustrates this when saying that "through development of social responsible computer artefacts, the conditions for an emancipatory practice are established" (ibid., p. 172). Naming this the Utopian approach, it is a very different version of technological determinism compared to the one found in pedagogical practice where the solution lies in the technology. The role of the interaction designer is more or less a question of identifying "aspects of systems that can promote or undermine user autonomy" (Friedman, 1996, p. 18). The term "critical design" is used to describe design processes aimed at "identifying blind spots and opening new design spaces" (Sengers et al., 2005, p. 50) based on feminism and ethnical studies, etc. Used in this way, it is a strategy for designing better products as it is argued "that reflection on unconscious values embedded in computing and the practices […] should be a core principle of technology design" (ibid., p. 49). Again, the technological determinism becomes obvious when it is asked how this approach can help to find and address blind spots, making it possible to make "design choices [that] may lead to improved quality of life?" (ibid., p. 49). Who are the ones having a better life? Does this critical design perspective include a critical stance towards its own practice, towards the pre-conceptions of the designer as well as the user? To some extent it does, but the close relationship between the conditions of humans and the development of technology is a complex one that needs to be discussed. A discussion present in Haraway's analysis of the meeting between human action and digital media (Haraway, 1985, 1991). This is a discussion that needs to be addressed in a systematic way within the field of interaction design, as the interaction designer without a doubt becomes an evermore important contributor in the design for human action. Even though the responsibility of the designer has been discussed (e.g. Nelson & Stolterman, 2003), it has not been discussed to any great extent in relation to power structures – neither as they are manifested in society at large, nor in how they become expressed in the design process. Again, core questions have been formulated within critical design that are worthy of much more thorough investigation: "As people adapt to the opportunities and constraints provided by our technologies, their everyday practices, feelings, even their identities and sense of self, may shift, often in unanticipated ways. As designers, we are left to wonder: what values, attitudes and ways of looking at the world are we unconsciously building into our technology, and what are their effects?" (Sengers, el al., p. 49). This is a question that becomes even more pressing as the products designed by interaction designers are ubiquitous in everyday life, working life and in pedagogical practice. Just think of it: what power structures are built into the learning management platform (LMS) you most frequently use? How are gender and ethnicity built into your

mobile phone? And what are the effects if these artefacts find their way into a formal educational setting? Gender, as with any other intersectional category, must be made conscious in any interaction design process, and especially so if it is to be used in pedagogical practice, as pedagogical practice is already recognized as a complex field of intersecting power structures. But, instead of pointing out the inadequacies of the two fields, let us finish off by presenting a couple of fields for future research.

Advancing the discussion

Both pedagogues and interaction designers are involved in a second order design problem, where they shape conditions for people, but are interested in secondary effects. The interaction designer shapes digital products and services, but aims to influence people's interactions with, and experiences of, digital products and services. The pedagogue shapes environments and activities for learning, but aims to influence people's competences and understanding of the world. The core interest of the interaction designer is often more or less neglected by the pedagogue, and vice versa.

In the meeting of interaction design and pedagogical practice it becomes crucial for interaction design to embrace these kinds of critical perspectives and theories, as the field of pedagogical practice has very little understanding of media in general, and digital media in particular. Here the field of pedagogical practice at large is in the hands of interaction designers. But do they have sufficient training, traditions or tools to carry out a critical evaluation of the benefits and shortcomings of a particular digital artefact in relation to emancipation, heteronormativity or intersecting power dimensions? Gender theory is so much more than having "women" as a category, or counting the number of users; a genuinely critical perspective is needed (c.f. Faulkner & Lie, 2007). Gender, and other structuring principles, must be articulated in any interaction design process, and especially so if it is to be used in pedagogical practice, which comprises a treacherous field of power structures.

Another important question is whether or not the technology contains any real emancipatory power. One is tempted to say "no", based on what we now know with regard to the utopian visions of the mid 1990s of humans freeing themselves from the heteronormative gender structures in real life, when meeting online (e.g. Nakamura, 2002). The power structures of our off-line world are, sadly to say, re-created online. And perhaps this was just a naïve vision, synonymous with the hopes associated with any other new artefact, that the Internet would turn the world into a better, and more peaceful, place. The same applies to the railways, the telephone, the television, the telegraph, and so on. But still, every artefact does affect us, how we understand ourselves, as well as how we understand the world we live in. If we, as a result of using digital media in a learning context, think of ourselves in new ways, is that emancipation?

As the fields of interaction design and pedagogical practice meet and share common interests, interaction design needs to move from the superficial idea of "design for all", to "use heterogeneity". This of necessity includes a critical examination of its own practice in all dimensions: Who designs what for whom, and in what context? What power structures are recognized, and how are they understood? To what extent are the specific user needs, interpretations and actions acknowledged? Pedagogical practice, on the other hand, needs to develop a way of critically examining digital artefacts/media, to be able to not just use digital media but also, and more importantly, to develop its practice. One step in that direction is most likely to appropriate digital media in learning practice as well as in learning theory, thus developing digital competence.

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GUEST EDITORS

Notes

1 Taken from Plato's dialogue "Phaedrus". Available from the Internet Classics Archive; http://classics.mit.edu/Plato/phaedrus.html

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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; Blevis, 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 hypothesises 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.

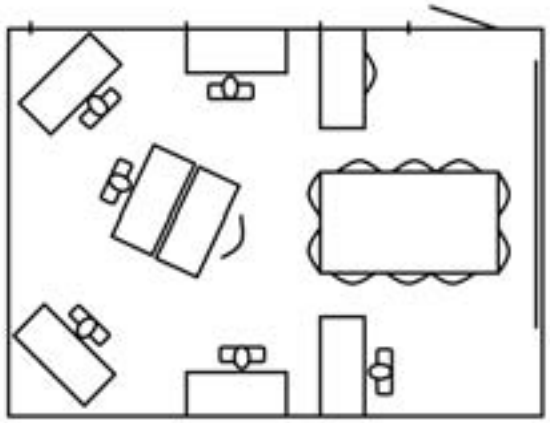

Figure 2. Layout of the studio.

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[1]) in the room as well as to use the same pointing devices at any other computer screen (Multibrowse, Pointright and iClipboard[2]). 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.

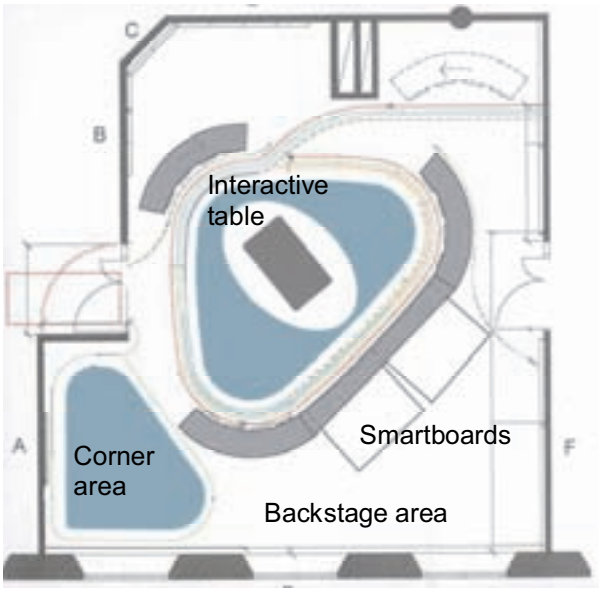

Figure 4. Plan of the room. The working areas are shadowed.

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 posses. 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 were 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.

Notes

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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Literate tools or tools for literacy?

– A critical approach to language tools in second language learning.

Abstract

There are important discrepancies between how language is currently represented by language tools, such as grammar and spelling checkers, and how language is understood in a broad view on literacy in second language learning. On the one hand, language tools do seem useful and important for learning linguistic form, but on the other hand they stand in possible conflict with pedagogies that emphasize the social aspects of language.

We approach issues in the intersection of digital literacy and language learning from a wide perspective on literacy, coupled with sociocultural theory and grounded in classroom studies. Based on our empirical work, we suggest that there is a need for complementary views of language to the one that propagates through current language tools. These complementary views could be reached through alternative designs of tools and education, reaching for a balance between linguistic form and communication of meaning.

KEYWORDS

Language learning • Grammar checkers • Interaction design • Sociocultural theory • Literacy

1. Introduction

Learning a second language is a question of literacy in the broad sense of gaining access to a language community and its modes of expression, on the levels of form as well as on the levels of discourse. In the digital age, this also includes digital literacies, ranging from understanding genres on the world wide web (WWW) to understanding how language is

represented by language tools such as on-line dictionaries and grammar checkers. Here, our interest is in the latter, having studied the use of language tools in the context of learning Swedish as a second language. We approach digital literacy from a broad perspective on literacy and problematize the possible conflict between correctness in form as being delivered by language tools and fluency in communication as the ultimate goal of learning a language.

Digital literacy is a recent and evolving concept, defined in various ways, and under various labels such as "computer literacy", "information literacy", "digital competence" or, as suggested by McMillan (1996), "comperacy". Broad, and somewhat fuzzy, digital literacy is a useful concept for discussing users' knowledge about digital tools in areas ranging from basic skills in using computers and operating systems to more esoteric issues such as what can and cannot be done by means of digital media. An important development lies in interpreting the term from this broad perspective, including issues such as questioning the source of online information, e.g. how the WWW allows new kinds of rhetoric, advertising, peer participation, etc. (Buckingham, 2006). One might say that this discussion concerns how various agencies and interests engage in collaboration or conflict in the online world, in the open (e.g. discussion forums) or surreptitiously (e.g. targeted advertising).

An important aspect of agency in the digital world is the agency possessed by technology itself. On the one hand it allows various human agencies to act in certain manners, but on the other it might also be said to display agency in and of itself. This is not to say that technology may act in human-like ways, but that it may act to redefine information by means of processing it. The implications of such processing are important, and must be examined and discussed in detail. On that note, we distinguish between "active" and "passive" digital tools (Knutsson, 2005, p. 14), where active tools are those that do something with information, while passive ones display untreated information. An example of an active tool would be a search engine, because it actively retrieves information from the WWW, and also condenses the found information before displaying it. Conversely, we call online dictionaries "passive", because they merely display content on request.

Historically, active tools relate to the distinction of autonomous software "agents" from other programs (see Franklin & Graesser, 1996; Nwana, 1996). Here, our interest lays in programs that process information linguistically (e.g. grammar and spelling checkers). The point of making the distinction is that what we call "active language tools" exhibit some kind of knowledge about language, thus presenting certain notions with respect to linguistic correctness, importance of surface form, quality of users' texts, means of improving texts, etc. This display of linguistic proficiencies has important ramifications for second language learners.

1.1 Language tools in second language learning

Our interest in active tools lies in language tools in general and grammar checkers in particular. Our area of research is within computer assisted language learning (CALL), where active language tools have potential to be quite useful, but may also pose challenges to pedagogic practice, and should probably not be introduced indiscriminately. Language tools represent especially important pieces of software for second language writers and second language composition teachers to use critically. More specifically, tools such as grammar checkers deserve special attention due to their "ubiquity, near visibility, increasing power, theoretical mismatch, and, conflict with and possible undermining of pedagogies that are today considered most effective for improving student writing" (McGee & Ericsson, 2002, p. 455).

The widespread availability of active language tools calls for a thorough, critical examination of how they influence the activity of writing. There is an unclear picture of how second language writers and teachers utilize active language tools for learning, and there is still much to investigate about how these technologies provide new ways of mediating, representing and communicating users' texts, on ideational (i.e. semantic and pragmatic) as well as representational (i.e. syntax) levels.

Digital literacy when using a language tool is interwoven with students' more paramount goal of achieving second language literacy (given that we are concerned with students who do have access to computers and language tools). Knowing how to judge output from language tools presupposes knowledge about linguistic terms in general, and knowledge in using the target language in particular. On the other hand, knowing "everything" about the target language in question would obliterate the need for a tool like a grammar checker, something not even most first language writers would attest to.

In this line of thought, we ask: i) What should second language writers know about the tool? ii) What do they need to know about language in order to judge output from the tool? iii) How should information about language tools be presented to the users? iv) How should these tools present information about language? These broad questions have guided us in our interrogations concerning digital literacy, second language learning and interaction design.

2. Digital literacy and second language learning

2.1 Approaching digital literacy

Scholars such as Street (1995), Gee (1990, 2003), Brandt (1998) and Säljö (2002) remind us that we cannot hope to understand any literacy until we appreciate the complex social and cultural dynamics within which literacy practices and values are situated. As Lankshear & Knobel (2006) note, digital literacy entails much more than learning how to use a program and a keyboard, how to do an online search or how to conduct a so called "web

evaluation". In fact, they argue, digital literacies exist in plural, because the issue is not merely how to teach a limited set of operational skills, but also how to draw from a multitude of digitally literate practices that school children and students are already participating in. In closely related work, Buckingham (2006) suggests a framework for a broad reading of the term digital literacy, viewing it from a critical approach towards information technology, rather than mere technical competence.

Buckingham (2006) outlines four useful terms in discussing how to approach digital media in a critical rather than a functional and skills-based manner: First, media, including digital media, *represent* the world rather than merely reflect it. There are always values and ideologies embodied in representations, and the reader should assess these. Second, in order to participate in discourse, one must understand how *language* works. Participating in discourse via digital media entails learning new codes and conventions of new and changing genres (as well as older and more static ones). Third, it is becoming increasingly difficult to judge who the *producer* of information may be. For example, commercial interests do not always reveal themselves, and should be guarded against. Fourth, a critical approach to one's own position as *audience* means understanding how media are targeted and how different audiences respond (or are intended to respond). We will revisit these terms in synthesizing aspects of second language literacy, language tools and digital literacy (section 4), reinforced by observations of second language students using language tools (section 3).

2.2. Second language literacy and language tools

Investigating literacies in operation when using language tools involves an examination of who the learners and users of technology are (*users*), what they are learning (*language*), and by which technological means they learn (*tools*). Our views on these matters are grounded in sociocultural theory, which emphasizes the social natures of mind, language and tools.

Users of language tools in a pedagogic context are simultaneously two different groups of people: second language students and second language composition teachers. Paraphrasing Lave & Wenger (1991), these two groups correspond to "legitimate peripheral participants" and " legitimate core participants", in a given digital and linguistic community of practice. The students' position in their new digital and linguistic community puts them in challenging situations, as their belonging and identity as community members relies on their way to find ways to move from the periphery to the core of it. In this journey, users of language tools will socially, physically and psychologically develop and behave as a consequence of the mediational means – artifacts and social relationships – made accessible for them or by them (Lantolf & Thorne, 2006). The tools and relations they will choose to interact with and construct or will have the opportunity to get to know, will shape their thinking and acting in a *language* that is not initially their own, but becomes so during their learning process.

The term *language* is a complex construct, being used in a wide array of contexts. Here, we do not intend to define it, but contend with understanding it as languages in plural. In the digital linguistic community there are many languages members speak. Furthermore, the term language brings together those using and teaching language as well as those developing and designing language tools, albeit their views on what it is are not always alike, or even compatible. Theories and views that encapsulate language (as syntax) from communication and use, in the structuralist and mentalist traditions, may be collectively seen as the language-as-an-object perspective, viewing form as the primary object of study. This is a view that is not compatible with approaches in sociocultural theory applied on second language learning, where language is studied as an organizing force of mind that structures thought, and creates and sustains social order (see Lantolf & Thorne, 2006).

Furthermore, the language-as-an-object perspective is not technically implemented in most of the language *tools* in use today, although their surface appearances may give that impression. Strictly adhering to any theory of syntax would result in very limited tools, which would be more or less unable to analyze the users' languages. Current computational methods are in many ways much simpler, and more fragmentary, partial and shallow, probably because it is more useful and interesting to develop an application that works than one that suits a particular theory. Language tools are made in programming languages that have the explicit purpose of expressing programmatic grammar to process natural languages. These grammars are *not* identical with, in many respects not even similar to, traditional school grammars. While the grammars are hidden away from users of language tools, they nevertheless affect the active programs that they use. Thus, there is an important mismatch between what users understand of language tools, and what they really are.

In addition, language tools are ubiquitous and are certainly "disappearing" in the sense of technologies that "weave themselves into the fabric of everyday life" (Weiser, 1991). In many respects, they have taken over the role played by traditional grammar handbooks. The proliferation of these tools in everyday life suggests that they do provide much sought-after linguistic advice in a conveniently available manner. In the case of second language learning, then, they are perhaps intuitively useful for a range of purposes, including linguistic feedback on student essays. However, these new actors are far from unproblematic, since their appearance also changes the pedagogic context of language learning in non-obvious ways.

3. Writing with language tools

The tool we have studied was designed as part of our research, in an iterative process towards novel language tools for second language learning (see Knutsson, Cerratto-Pargman, Severinson-Eklundh, & Westlund, 2007 for a detailed description.). The "tool" con-

sists of several linguistic tools, and should be thought of more as a linguistic "environment". Most prominently, it contains grammar and spelling checkers with added functionality such as verbose explanations of errors and linguistic information about words and constructs. There are other, subtler, features such as the option to highlight words according to the part of speech. Here, focus is on the checkers, since these are what students most sought after and used in our studies. Our intention is that critical inquiries may lead to further iterations in design, with the goal of conceiving of better tools and tool use.

We have chosen to highlight the following observations concerning problematic uses of language tools: *misdirections* from output, *misinterpreting* the task of revision and *indiscriminate use* of the tools. There is certainly some overlap between these categories; they are merely intended to highlight issues with the tools in use, rather than provide an exhaustive description of data. Note that we highlight problematic issues for illustrational purposes. There were of course unproblematic uses of language tools as well, for example, when the tools suggested relevant changes, or when the tools instigated discussing and thinking about texts and language among students.

Being able to discuss linguistic constructs in the target language also means that learners were far from "illiterate" with respect to digital tools and the Swedish language. However, this shows how important the issues are, because even quite competent users may sometimes be steered into problematic uses. Our examples consist of dialogue and/or text excerpts from classroom (in some cases voluntary after-class tutoring) settings where second language learners of Swedish participated in pair-wise or singular tasks concerning text revision, where active language tools were introduced.[1] We have translated data from Swedish to English, retaining errors as accurately as possible (erroneous constructs are of course notoriously difficult to translate). Underlined words in text excerpts are those that were marked as erroneous by the checkers.

Misdirections: occurred when output from the error checkers directed students towards false conclusions:

- **Written:** nowadays it is a basic science that one need almost in all the *sciencors* one can think about (marked as incorrect)
- **Changed into**: nowadays it is a basic science, that one needs almost in all the sciences, that one can think about (marked as correct)

The two students working with this text discussed the error markings at some length, in particular being troubled by the first one, which was in fact falsely reported by the checker. They ended up adding a comma that satisfied the checker, but was not grammatically necessary. They also corrected the other reported error into an existing form, as well as the unreported error in the tense of "need". Furthermore, they added the extra "that" and the comma before it, probably because they had learnt that it was "needed"

from the first example. Thus, being misdirected by the first form probably led them to repeat an unnecessary construct, rendering the sentence awkward (and with an issue with the determined plural of "sciences"), but without error markings.

Misdirections of this sort appeared because the checkers had missed an error or marked something as erroneous where it was not. Inaccurate output is a well-known limitation in all grammar and spelling checkers, not just the ones we studied. "Complete", teacher-like linguistic coverage entails tools that possess human-equivalent intelligence, which is probably not possible (see e.g. the seminal works by Dreyfus, 1992; Searle, 1980; Winograd & Flores, 1986). For first language users this issue with language tools is not so problematic, because writers frequently (but not always) already have enough literacy in their own language to judge the checkers' output appropriately. Some misunderstandings will always be present, being in the nature of learning. However, the very strong trust students put in the error checkers rendered them problematic.

Misinterpretations occurred when students acted on output from the tool in a manner that suggested not understanding its intent, or the intent of the task of text revision. In other words, they were sometimes led to lose sight of what they were attempting to express, and how they were expressing. For example, they sometimes inadvertently changed the meaning of their text as they struggled to get rid of an error marking:

> **Written**: It was scandal to see a countess mingle with a farmhand. (Marked as incorrect)
> **Changed into**: It was permitted to be angry if one saw a countess mingle with a farmhand. (Marked as correct)

> **Written**: ...called the ambulance so that they take her to the hospital (marked as incorrect)
> **Changed into**: ...called the ambulance because she was taken to the hospital (marked as correct).

In the first example the student did not understand why "scandal" triggered an error marking. She looked it up in an online dictionary, where it was explained as "permission to be angry". The first form contains a (correctly reported) minor error in inflection, while the second is an unintentionally odd wording. She chose to accept the dictionary definition word by word, replacing her wording with a misinterpreted one that was marked as correct by the grammar checker. Thus the checker first instigated the misinterpretation by not being able to provide clues to what the error really was, and then reinforced it by marking the result as correct.

The second case starts with a misreport; an error exists, but not as underscored. Again, students changed the meaning of the sentence in a way they probably did not intend, but ridding the text of the "error".

Finally, *indiscriminate evaluation* illustrates the authority given to language tools. They were elevated to a status of being the yardstick by which to measure linguistic com-

petence. This is problematic because no grammar checker can live up to that role, and even if they could it is questionable if they should. In a sense, students were rid of responsibility for their texts. For most, finishing as quickly as possible, and with no error markings became a goal, rather than producing a coherent, well-written text:

> **Jean:** okay so mm / but it's good because i had three typos (xx) maybe two errors yes (xx) three more errors hu / even if I had read through it once more (xx) mhm

Others became uncertain about their own abilities when in conflict with the grammar checker:

> **Written:** [The book] was not only love. (Not marked as incorrect)

This student complained verbally that the word "about" was probably missing, but that the error was not reported by the grammar checker. After being occupied with this for some time, she gave up and let it stand as it was, not willing to go against the checker's advice (or lack thereof).

These issues are problematic because grammar checkers are intended to provide help on the way towards a better text, but the final word on the text should be its writer's. In order to use language tools for learning, it is important that they are introduced to the learning environment in a critical manner, allowing and encouraging students to not always accept output from them at surface value. This is important for two reasons, 1) that the tools have technical limitations, and may not always be correct, and 2) that a fixed notion on "correctness" is the ultimate goal of neither writing nor learning. In writing, it is ultimately more important to express meaning, and in learning language it is ultimately more important to acquire fluency in writing and speaking, to make oneself understood in a new language. The question, then, is how to encourage students to attend to form, while not letting form take over.

4. Discussion

4.1 Interpretation of second language learners' use of language tools

A broad view on digital literacy concerning language tools is about encouraging a critical approach to language tools. It is about having a healthy level of distrust of the tools' grammatical knowledge and explanations, and about being critical towards the very notion of surface correctness as a measure of language proficiency or text quality. If we assume that language tools have a mediating role in users' writing, we must also try to uncover the structures and knowledge "embodied" in these tools. This is a part of what Haas (1996, 1999) calls "The historical-genetic method" based on Vygotsky's ideas, which

includes the historical study of how the tools were developed, how the tools are transformed by use, and the transformative power of tools on consciousness.

We have seen that the language-as-an-object perspective is inevitably existent in the users' apprehension of language tools. It appears in the current surface output from the tools, in the way the tools are used, and it is then probably influential in how students form their views on language. We revisit the terms *representation, language, production* and *audience* (Buckingham, 2006) in order to interpret and discuss how language-as-an-object occurs in digital literacy concerning second language learners' use of language tools.

Language tools may *represent* a view of language that treats it like an object, as observed in our studies as well as in studies by Vernon (2000) and McGee & Ericsson (2002). This view includes beliefs, implicit values and ideologies concerning correctness. Therefore, second language students need to be able to evaluate the material they encounter, addressing general questions in digital literacy concerning authority, reliability and bias (Buckingham, 2006).

The kind of language evaluation that language tools provide may presume that objective truth about language can eventually be reached through a meticulous process assessment and comparison of different sources of information. However, no such exhaustive objective truth about language exists. As Fabos (2004, p. 95) suggests, students therefore need to understand that language is not neutral, that there is no ultimate correct text, and that political, economic and social context matters. While the full scope of these issues is probably too large for most learners (after all, they want to learn a language, not communication theory), teachers and tool designers do have a word on what view on language to mediate.

Questioning whose view on language is represented includes questioning what this view on *language* means for second language learning. Importantly, the critical view on representation in digital literacy expressed above is consistent with a sociocultural view on second language literacy. Learning a language is far from solely learning about surface forms. It is about learning how to mean; language is profoundly social, mediating between the individual actor and the cultural and historical milieu within which that actor works (Haas, 1999, p. 212; Halliday & Mattiessen, 2004).

Viewing language as an object may understate communicative and social aspects of language. Second language students do need to receive education about how the given target language(s) in question works with respect to more or less correct (socially accepted) surface forms, but also about how language emerges socially and how codes and conventions of particular genres affect writing (Halliday & Mattiessen, 2004; Knapp & Watkins, 2005). Reading and writing are purposeful activities in which the reader/writer constructs socially situated responses to particular contexts and communities (Hyland, 2003), and learning a second language goes beyond mastering a target gram-

mar, intimately linking language to significance (Lantolf & Pavlenko, 2001). People do not just write, they write to accomplish different purposes in different contexts (Hyland, 2007), and functioning independently is learnt by interacting in socioculturally meaningful activities (Zuengler & Miller, 2006, p. 36).

Literacy involves understanding who is communicating to whom, and why. Active language tools might be said to communicate, in the sense that they *produce* responses to learners' texts. Of course, the rules embedded in language tools reflect some programmers' views on grammar and language, but once tools are released to users, the programmers' views are not directly perceptible. Active tools are differentiated from passive ones by having been given agency to judge language without necessarily referring to a human. In particular instances and reports, then, the tool's reports may or may not be consistent with first language speakers' notions of accuracy, including its developers' notions.

Thus, there are two major agencies to consider regarding production of responses to users' texts: the tools in themselves, and their developers. The language output from tools may be more or less accurate, more or less authoritative, and more or less directed towards formal syntax. Furthermore, its developers may have interests in the formalities of language, and these interests may be more or less known. For example, McGee & Ericsson (2002) question the authority given to the grammar checker in Microsoft Word (called MSGC). How is a large corporation ascribed knowledge about and power over representations of language, and how is that knowledge and power exercised? Some users contend that MSGC is a largely unproblematic mechanical delivery system for the grammar found in handbooks, while others are offended by the very notion of simply tossing handbook grammar at students. The reality is, however, that MSGC is *not* an accurate representation of handbook grammars, and in fact it is far from transparent exactly what representation of grammar it does have. Therefore, it puts its developers in possible conflict with other stakeholders (handbook and dictionary authors, government agencies, pedagogues, learners, etc), in how language should be represented. Of course, the tools we have studied are no exceptions. They offer different, and competing, views to MSGC, but may be questioned on similar grounds, considering the authority given to the tools by language students.

Finally, the second language learners' position, viewed as *audience* of a language tool may be questioned, from the outside by researchers and pedagogues as well as by learners themselves. This means developing awareness of how access to language tools was gained. Did a teacher introduce the tools with certain pedagogical goals in mind, or were they merely included in the word processor of choice? Furthermore, it is important in what manner students are addressed and guided by tools, in particular if they are to be corrected. Students may feel inadequate questioning a computer's feedback about their writing while they are also learning how to express themselves in the very language that the feedback concerns.

In the light of the misappropriations presented in section 3, and the related work and theoretical standpoints above, one might pose rhetorical questions to all stakeholders in the use of language tools in second language learning. In what pedagogical context are language tools used in your second language classroom? What is the place of technology in this specific type of learning? How are language tools used and understood by their users? How are language tools shaping natural language(s)? How do language tools influence ways to talk about language? There is no one correct and exhaustive answer to these questions, answers will differ depending on variables such as the level of the students, the pedagogical rationale of their teacher, and the design ideas expressed by developers. Nevertheless, in the sociocultural view on language and communication, the language-as-an-object view is problematic; at least insofar it overshadows communicative aspects.

4.2 Second language learning at the intersection of digital literacy and interaction design

We suggest three approaches by which the issues we have presented may be tackled. The questions ending 4.1 above concern *education,* but also *interaction design*, and the general descriptions of *language* to be found in output from language tools as well as in many textbooks about language. In all three domains, there are several ways out of the prevailing language-as-object perspective. Language tools do not differ from other tools in that they are products of science, and social, cultural and technological development. As is the case with many other tools, developers often have a specific group of people and human activity in mind when designing computer programs. This concerns the user interface, and more deeply the interaction between the user and the language tool, and the kind of language the developers of the tools assume that writers use, or need to learn.

First, the *interaction designer* can change the use experience, for example by considering use qualities such as pliability (Löwgren, 2006). Löwgren uses the example of an interface to a thesaurus, a passive tool from our point of view, which is made more pliable by a visualization tool. The result from a search in the thesaurus is presented visually as a network of related words. The result is a stimulating design improvement of a passive language tool that makes the passive tool behave more like an active tool. Active language tools must have even better chances to supply the user with interactive visualizations, and pliability, with their ability to react to the user's writings in different contexts. Currently, we have not seen very much of this in the design of active language tools. We call for a marriage between interaction design and language technology when developing software for writing.

Regarding *education*, teachers may consider adapting the tasks for learners when using language tools, and thereby adapt the use of language tools in order to follow their pedagogical choices. Successful application of task design, and the use of language tools has been shown to encourage students to experiment, reflect on their language, and not

misappropriate language tools in the manners shown above (Karlström & Lundin, forthcoming). In this case, the pedagogy of choice was based on genres (Knapp & Watkins, 2005), but there are of course many other pedagogical choices, depending on setting, level of students, teacher preferences, etc. Heift (2001) reports on a study where students participating in more traditional tasks concerning linguistic form using language tools opted to take the difficult route of working through exercises rather than immediately receiving the correct answer. Task design is an aspect of interaction design; there is no clear boundary between interaction with a tool and the context in which it is used. Constraints used in the task design may be transformed and integrated into language tools, and reused by other learners in other contexts, provided that teachers are aware of how the tools may affect the specific situation.

Finally, how the target *language* is described and explained to learners in general is an issue of utmost importance. However, since language avoids any one definition and exhaustive explanation, the proportions of this issue render it out of scope for any design of task or tool. There are historical and cultural ramifications of language-as-an-object involving how language has been explained since grammar, or even the alphabet, was invented (see e.g. Hopper, 1998; Linell, 2005; Pettersson, 1996). Still, the field of language technology does not necessarily have to subscribe to the language-as-an-object perspective, and may instead focus on the development of algorithms that take the usage based linguistic stance as a staring point (Tomasello, 2003, p. 6). From this perspective, language is viewed as a complex and diverse set of linguistic representations including grammar, prefabricated language constructs, idiosyncratic constructions, concrete phrases and word meanings, among other things. An illustration of this perspective is Wittgenstein's words from Philosophical Investigations (1958): "Our language can be seen as an ancient city: a maze of little streets and squares, of old and new houses, and of houses with additions from various periods; and this surrounded by a multitude of new boroughs with straight regular streets and uniform houses.". On the horizon of language technology there are some initiatives that are becoming mature enough to be explored in this manner, for example, the so-called word-space model (Sahlgren, 2006), and the application of those in the area of second language learning (Baba, 2004).

Altogether, we propose that there is an urgent need to start developing and designing language tools that enable users to explore meaning related aspects of the complex nature of (the target) language(s). A starting point for such an effort would be, through user-centered and iterative design processes, to develop and design language tools, and tasks that guide their use. The goal would be to design tools that are able to support and visualize a much more complex view of language than the traditional formal approach.

5. Concluding remarks

In order to discuss digital literacy in the context of using language tools when learning a second language, we have drawn from a wide range of sources: sociocultural theory, literacy, digital literacy, interaction design and empirical studies. The issue is complex, primarily because the mismatches between the views of language-as-an-object versus language as a social tool appear in a wide range of discussions. To further complicate the issue, the inner workings of active language tools have little to do with the view on language that they present. This is not a problem in itself, but it becomes a problem when they are ascribed knowledge (and status) that they do not possess. We have seen concretely how these issues affect the real-world use of language tools, and have suggested that interaction design, including task design, might provide means for learners to more critically reflect on the active language tools that they use. One of our own suggestions in this direction is to encourage linguistic reflection by means of visualizing language (Knutsson et al., 2007), coupled with appropriate pedagogic tasks (Karlström & Lundin, forthcoming).

Language tools are here to stay. Changes in development and design will continue to shape users' interaction with others and others' language(s). In this respect, efforts from the educational side are equally important. In particular second language and composition teachers have an important task to accomplish. They must think carefully about the implications of the use of technology in their classrooms (McGee & Ericsson, 2002, p. 454). Not only do educators need to appropriate language tools in their practice, but also they need to reflect on their use for their specific pedagogical purposes. Furthermore, they are expected to teach students 1) to think about the language(s) they write or would like to write and 2) to be aware of the pragmatic effects of their words. As Berlin (1996) suggested, the task of teachers is to enable students to penetrate semiotic codes, and enable them to see how the languages they will speak are ways of thinking and acting, and reflect regimes of power. Language tools are far from neutral on that matter, and their current implementations may not be as "literate" as they seem.

Notes

1 We illustrate issues with language tools by brief excerpts from a collection of data from the Swedish project "The use of language tools for writing Swedish as a second language" (see Cerratto-Pargman, Knutsson, Karlström, & Severinson-Eklundh, 2006). Methods principally consisted of analyzing interactions between student pairs and student and teacher that had been recorded on video and audio media, analyzing progressive changes in their texts, as well as questionnaires and interviews, and technical evaluation of language tools. For detailed descriptions of methodologies and results, we refer the reader to

Knutsson (2005), Karlström, Cerratto-Pargman, Lindström & Knutsson (2007), Knutsson, Cerratto-Pargman, Severinson-Eklundh & Westlund (2007), Pihl, Rastas, & Rockberg-Tjernberg (2003), Lindström (2006) and Karlström & Lundin (forthcoming).

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Artefacts and the performance of an exhibition

Abstract

This article explores the role of mediating artefacts in children's encounters with a museum of natural history. Using actor network theory it explores how a specific artefact shapes the way users relate to exhibited objects and how the artefact guides users' movements in the exhibition. The mediated performance of an exhibition is explored through an empirical case.

KEYWORDS
Mediation • Artefacts • Performance • Museum

The boy looks for answers. He plunges deep into the blue, blue. Hears the eerie sound of huge underwater mammals. Singing. Howling. He swims, he climbs, he crawls. Nostrils loaded with a rancid smell of whale he steps on land. Walks the shore. Feels the soft texture of Brown Bear between his fingers.

I am The-Bear-You-May-Touch.
Find me in the exhibition and feel how silky my fur is.
I like to eat both animals and plants.
Find me on the computer and mark what I eat.
Plants. Ants. Dead animals.
Deer. Berries. Rocks.
During winter it is difficult for me to find food, so I find a warm cave and sleep.
Can you draw me in my cave?

Later he sneaks, his body clad in animal. Soft. Foxy, fur toupee. He approaches her from behind. Sister sweet. Long, blond hair. She is absorbed, she looks through the lens, zooms in, catches a bear. CLICK. He jumps. Sharp carnivore fangs.

Inquiry: How artefacts participate in the performance of an exhibition

This article focuses on interaction in a modern museum of natural history. The article explores what mediating artefacts do to the way children encounter a museum exhibition. Central attention is given to a portable device called *the exercise pamphlet*, but other artefacts are also involved in the analysis: *digital nature-bases*, *animal costumes* and *mobile phone cameras*. The aim is to illustrate how artefacts participate in visitors' performances of a museum exhibition.

The initial text in the article is based on an exercise pamphlet called "*Say hello to us*" and on empirical observation of two children, Jakob (9) and Camilla (13), and their encounter with the museum exhibition (audio 0013). (See Czarniawska (2004) for a discussion of the use of narrative in social science.)

In the observation the boy, Jakob, uses the mediating artefact of an exercise pamphlet. It takes him to different areas of the museum and instructs him to do several things. He is told to touch a bear, and he is told to find a computer in order to obtain information on it. Jakob also interacts with another mediating artefact. He encounters an animal costume, which children are allowed to dress up in. He puts on the fur of a fox. Wearing it he attacks his older sister, Camilla, while she is using her mobile phone camera to take a picture of an exhibited bear.

The points which the article will make about the role of mediating artefacts in children's encounters with the museum are that: 1) exercise pamphlets guide and prescribe how users move around in the exhibition, 2) the prescriptions made by exercise pamphlets are contested and negotiated by other artefacts, 3) users switch between different artefacts, and 4) with these shifts follow shifting networks and spatialities.

What users do in and with an exhibition – and specifically what they do with mediating artefacts in the exhibition – are central interactions in a museum. The study of these interactions provides insights which are useful in the pedagogic practices which take place in and make use of a museum exhibition. It shows how children use an artefact, which is produced for the purpose of teaching them natural history/biology. It shows how such an artefact may both enhance and diminish children's interaction with another artefact, which also has the purpose of teaching children natural history/biology: computer databases. Furthermore it shows how artefacts which are full of pedagogic intentions, such as the exercise pamphlet, exist parallel with users' interactions with other artefacts, which are not necessarily loaded with pedagogy in the same manner as the exercise pamphlet. An example of this is the mobile phone camera, which visitors' use frequently, but which is not embedded in the museum's institutionalized pedagogic practice.

Method: Fieldwork in a museum

The article is empirically generated from fieldwork at a museum of natural history. Data has been collected throughout the course of a year. The research is based on several types of qualitative data consisting of observations in the museum, a special kind of video-registration, which has been developed for researching visitor experiences in exhibition spaces (Ingemann 1999, 2002) and qualitative interviews.

Observation data has been collected with visitors ranging from the age of 2 to after retirement, but towards the end of the data collection process, increasingly focus was placed on children aged 7–13. The collected data is extensive and covers children on both leisure visits and school trips. In the further work with data, it has been useful to focus on a smaller number of children, and to extract their data from the larger pool of data in order to build coherent accounts of their visits. In this way data is rearranged to portray the actions of one child (with fellow visitors) at a time.

This re-arrangement of the observation data is supported by another central data source. An important type of data collection which has been used in the project is the registration of visitor interaction with the help of a pair of video-glasses. Museum visitors wear a pair of glasses with a built in camera and microphone. The camera registers what the museum visitor looks at, how long they look at it, when they move and to where. Furthermore it registers what they say, when and how. This enables a close analysis of how subject-object and subject-subject-object interactions occur. This type of in-depth registration has been carried out with five visitors. A variation of this method, where the researcher wears the video-glasses and follows the visitor, has been used for two more visitors. They have all been on leisure visits to the museum, and have been accompanied by family members. The latter variant of the method has also been used for a series of institutional visits.

Qualitative interviews have been carried out with both visitors and employees. The data presented in this article are from a series of interviews and four observation sessions: walking observations of Camilla and Jakob. They are a sister and brother aged 13 and 9. They are at the museum with their mother and grandmother. The family has purchased an exercise pamphlet for Jakob. This observation was registered as an audio-recording, where I described what the children did. I did not have an agreement with them in advance, but during a break in their visit, I approached them, told them about my project, and conducted an on-site mini-interview. The audio of my observations and the interview have been fully transcribed.

A video-registration where Fie, a 7-year old girl, wears the glasses. She is at the museum with her older brother and her mother and father. Both Fie and her brother Teis have exercise pamphlets. They have two different kinds of exercise pamphlets. The purchase of these happens at the family's own initiative. Towards the end of the museum

visit, when Fie wanted to take the glasses off, I conducted an on-site mini-interview with her and her family. The video and interview have been fully transcribed.

A video-registration where Bea, a 10-year old girl, wears the glasses. She is at the museum with her parents, an older brother and two younger sisters. Bea and her family have two different kinds of exercise pamphlets with them. I know this family in advance, and have asked them to participate in the project. The acquisition of the exercise pamphlets is suggested by me. The video has been fully transcribed.

A video-registered observation where I wear the glasses and follow Johannes (9), Ane (12) and Sara (13) as they visit the exhibition. They are at the museum with their mother and grandmother. Exercise pamphlets are purchased for all three of them. Johannes has one kind of exercise pamphlet, Ane and Sara have another kind. I did not have an advance agreement with these children. The video has been fully transcribed.

The analysis of data has occurred at four stages: in the field, during transcription, while reading the transcribed data and while writing. Data are analyzed through theoretical interpretation (Kvale 1984). The primary intellectual tradition which is used is actor network theory.

Include materiality to understand performance

There is a growing orientation towards *materiality* within social science. Pels, Hetherington and Vandenberghe (2002, p.5) call it 'a new materialism': "Objects are back in strength in contemporary social theory… After poststructuralism and constructivism has melted everything that was solid into air, it was perhaps time that we noticed once again the sensuous immediacy of the objects we live, work and converse with, in which we routinely place our trust, which we love and hate, which bind us as much as we bind them." (Pels, Hetherington and Vandenberghe 2002, p.1.).

This orientation towards materiality is also found within the research fields of museum studies (Hetherington 1997, Hetherington 2002), leisure and tourism studies (Bærenholdt 2007, Haldrup 2006, Haldrup and Larsen 2006, Ooi 2005) and within the broader field of geography (Murdoch 1998).

When the article focuses on the *performance* of a museum exhibition, it does so because it draws on research within cultural and social geography, which asserts that in order to understand a place such as an exhibition, it is necessary to understand *how this place is performed by users* (Bærenholdt 2007, Bærenholdt et al. 2004). This performance perspective draws heavily on practice theories, and is rooted in a cultural and social geographic tradition, which sees place and space as practiced and relational. (Bærenholdt 2007, Haldrup and Larsen, 2006, Haldrup 2006, Murdoch 1998, Simonsen 2005). It implies: "that no sharp dividing line should be drawn between leisure, tourism and everyday life practices. (…) they connect, overlap and are woven together in human, social and embodied practice through various performances (such as movement and

memory) of various tourist and leisure spaces." (Haldrup and Larsen 2006, p.276).

Research in this tradition stresses that material artefacts are central to how users practice, perform and experience place: "Nature, landscape and leisure spaces emerge from the material 'lay geographies' performed by their practitioner. They are not prefigured but made – and made sense of – through *practical* actions. (…) Places and landscapes are not encountered 'naked' but through the deployment of a variety of 'prostethic' objects and technologies. Technologies are central to how people appear to grasp the world and make sense of it. They are crucial to how places are (or can be) encountered and perceived." (Haldrup and Larsen 2006, p. 279 f.).

In order to understand how users perform a place we must closely study which material artefacts users interact with and how these interactions take form.

This article presents such a study of how users encounter a place with things. Using an actor network theoretical vocabulary it explores how a specific artefact, the exercise pamphlet shapes the way in which users relate to exhibited objects and how the exercise pamphlet guides the user's actions and movements in the exhibition. It illustrates how visitors interact with portable artefacts while performing an exhibition. The analysis uses an actor network analysis to portray an empirical case of *how artefacts participate in the performance of a museum exhibition*.

Case: The museum exhibition

The museum opened in 2005. An important feature of the museum is its modern architecture. The exhibition is located in a large circular space with an open core in the centre. It is divided into three levels, Water, Land and Air. The animals are exhibited on podiums and not as in traditional museums of natural history, shown in their habitat. The animals are staged with light and music which changes all the time. On Land a multimedia show plays continuously 24 hours of day and night in a loop of 1½ hours. Sound and light change from the energetic rhythm of sunrise to calm, starry night. At times thunder and rain break the air.

Signs with the names of animals are seen in proximity to the animals, but no further information is provided here. Information about the exhibited animals may be found on computers called *nature-bases*. A nature-base is a computer and mouse setup positioned in different locations in the exhibition. The idea is that by using these computers visitors can seek out information about the animals in which they are interested. Furthermore the computers are included as reference points in the formalised educational activities which the museum offers to visiting schools.

In evaluations visitors have expressed that they experience a lack of accessible text about the exhibited animals. To compensate for this some columns with display text have been added to the exhibition.

Encountering the exhibition with exercise pamphlets

A common way for children to experience the exhibition is by means of different kinds of exercise pamphlets. Exercise pamphlets are sold at the entrance to the museum and are used by children visiting the museum with both their families and on school trips. Almost a third of the children who visit the museum do so in the company of an exercise pamphlet (statistics from museum).

Exercise pamphlets are a printed set of papers. Some exercise pamphlets contain questions about the subject matter of biology and about the exhibited animals. Other exercise pamphlets have pictures of animals, which may or may not be found in the exhibition, and a task for the visitor to complete.

The museum continuously produces exercise pamphlets, and there are variations among them, both as regards content and where the visitors should go in order to solve exercises. Answers to the exercises may be obtained from the exhibition and its related information architecture – for example in digital nature-bases, but also on posters in special exhibitions and in other written material.

Children are awarded a prize (in the form of a poster) when they have completed the exercises.

Exercise pamphlets guide users and prescribe their movements

Following actor network theory, we may explore the exercise pamphlet as an entity which participates in the performance of *a network of relations*. To understand an entity we have to understand its relations to other entities (Law and Hassard 1999).

In the initial quote from the exercise about the brown bear, we can clearly see how relations are inscribed in the exercise pamphlet (for example a relation to an exhibited bear). With these relations are also inscribed suggestions as to how the user should interact with the exhibition. The exercise pamphlet both directs the user to a location in the exhibition: "*find me in the exhibition*", and *"find me on the computer"*, and instructs the user what to do: *"feel how silky my fur is*", "*mark what I eat*".

In this way the exercise pamphlet shapes the child's interaction with the exhibition. The child's attention is directed toward specific aspects of the animal (how the fur feels, what the animal eats), to specific aspects of the exhibition (that there is a bear on exhibition, and that this bear is an animal which it is permitted to touch) and to specific locations in the exhibition (go to the computer).

This latter aspect – that an exercise pamphlet makes the child go to specific locations in the exhibition – may also be seen in the following video-transcript. Fie (7) is at the museum with her mother, father and older brother. Fie is wearing video-glasses. The visitors have spent some time on level Water, and are now on their way to Land.

They walk up the stairs from Water to Land and Fie comes to a point where she can see something that to her resembles a musk ox.
Fie: Oh- Søøøreen-ng (the name of her father, said in an eager, singing manner): I have found the one for our last missing question.
Her father doesn't reply.
He says to his wife: Those exercise lists should be banned.
Fie ignores this. She once again tries to involve him in her action.
Fie: But Dad, it's right over here
Fie: Yeah, but I'm gonna go right over there, because there it is.
Dad: OK
Fie: see ya'

(00:22:00)

Fie takes off walking. She enters the exhibition on level Land. She passes elk, reindeer, a large brown bear, she doesn't look at them, and she doesn't stop at them. She goes directly to the Arctic podium.

(00:22:50)

She arrives at the Arctic podium. Looks around a little. Sees a column sign. The text is in English.
Fie: English
She moves. Finds the Danish text. Reads out loud:
Fie (reading out loud): Musk ox, it *was* a musk ox.
Writes on her exercise sheet while vocalizing: "muuuuuuuskk –oooox."
Continues writing and vocalizing: ooooooooooo-x.
She turns around, sees her brother who says her name.
Teis: Fie
Fie: It was a musk ox, like I said.
She hums, stands, looks around for a little while.

(video 005)

This interaction shows that the exercise pamphlet establishes relations between itself, a user, exhibited objects and accompanying information architecture. The exercise pamphlet is not a separate entity. It is an entity which is associated with (and associates itself to) other objects. The exercise pamphlet establishes relations between the exhibited animals and the visitor.

The exercise pamphlet is central in the creation of a network. It draws together certain objects in the exhibition, and establishes connections between these objects and visitors. The exercise pamphlet participates in the creation of a net of associations. This net of associations is made manifest when the exercise pamphlet and user interact. The exercise pamphlet contributes to certain modes of movement, where the museum is performed

spatially and temporally according to an order which the exercise pamphlet participates in creating.

10-year old Torkild, who is at the museum for his third time, explains how the exercise pamphlet takes him around in the exhibition:

> Torkild: You go and find the animal, and then you can read what it says there.
> Int: And what does it say? You see, I haven't tried to solve these exercises, so I don't really know what you do.
> Torkild: Well, it says, for example, if it is a sparrow, then it has this number, down below on a sign, a little sign, a medium sized sign, and then you can go to the computer and read on it.
> Int: OK. And what are the exercises about?
> Torkild: Well, that you have to walk around and find the animals and stuff.
>
> (audio 0027)

The exercise pamphlet guides the boy to specific locations in the exhibition. In Torkild's explanation of how he finds answers, we can see that several entities are related. The exercise pamphlet is the initial entity. The pamphlet mentions an animal that he is to solve an exercise about. Torkild's strategy for doing this is to find the exhibited animal on a podium. He knows that there is a sign located nearby, and on that sign is a number. This is the third entity. With the number he can access information on the computer, which becomes the fourth entity in this net of actions.

The exercise pamphlets create certain forms of action, and with/in these actions relations are established between users and exhibited objects. In this way exercise pamphlets are central in the creation of networks of action.

The exercise pamphlet tries to prescribe the behaviour of the entities which are aligned in its network – the user of course being the most mobile entity. The exercise pamphlet "defines a framework of action along with which the entities and spaces are supposed to act. (Akrich 1992)." (Murdoch 1998, p. 363).

The exercise pamphlet is part of a standardised network, which attempts to configure the visitor into a specific set of actions, to inscribe certain patterns of action on the visitor, and thus to inscribe specific performances of the exhibition.

The exercise pamphlet negotiates with other objects

In the following excerpt we see another example of how an exercise pamphlet pulls at a visitor, but we also see how this pull does not stand alone. First the exercise pamphlet pulls the visitor *from* a conversation about how climate changes affect polar bears *to* some stolen Easter eggs. Then this course is interrupted by a digital nature-base which says something about whales. Ultimately the exercise pamphlet comes back strong – enforced by the body mass of a walrus.

Bea (10) walks down the stairs with her brother Anton (12). Bea carries an exercise pamphlet. The purpose of the exercises is to find "the animals who have stolen an Easter egg". At different places in the exhibition a colourful Easter egg is placed next to an exhibited animal; the animal has stolen an egg. The exercise pamphlet carries pictures of these animals, and of some more animals who *have not* stolen any eggs. The task is to put a mark next to the animals that have stolen an egg.

Bea and Anton are talking. They have just passed a polar bear and Anton says that they are becoming extinct.

(00:06:00)

Bea: Why are they becoming extinct?
Anton: Well, because the ice is melting, you know.
Anton: And they are called polar bears. They live on the ice, and then they don't have any ice to live on.
Bea: What a pity for them, huh.
Bea: I wouldn't mind having polar bears in Denmark. No, *no*.
Bea (exclaims): It has stolen an Easter egg!
Anton: Yes! It has!
Bea: juhuu
They take off running down the stairs.

(video 007)

When Bea arrives at the bottom of the flight of stairs, she sees a computer, a nature-base. It is the first one she sees on her museum visit. As she stops at the nature-base, she asks her father who has also come down the stairs, what it is.

Bea (reads aloud): Water. Land. Air. Animals on land.
Bea: What is it?
Father: It is something where you can enter and read about it.
F: Try to click on Water, which is where we are now.
Bea: And Land as well.
Bea: Where do we start?
F (reads out loud): Choose an animal from where it lives, or change the overall category by clicking
F: well that's up to you
Bea (reads out loud, hesitantly): Toothed whales and balee-
F: Baleen whales, those are the largest.
Bea (reads out loud): Did you know that…
F: the humpback whale

(00:07:30)

Bea (looks at nature-base screen, clicks mouse, reads out loud): The humpback whales are known for the longest and most comp – I can't read that
F: the most complex singing... that means that, there are a lot – it means that language-wise it is
Bea: the one that talks the most
F: yeah
F: wow – 180 DB – that's incredibly much – it's more powerful than a jet plane

(00:07:44)

Bea looks at her dad.
F: it is…
Bea continues to gaze around.
Bea (fulfils his sentence): …oh, wow, really incredi – (sees the walrus, interrupts herself): Did you put an X next to the walrus?
F: No, I haven't put any X'es anywhere; don't you want to do it?
Bea: yeah

(video 007)

This excerpt shows how the nature-base exerts enough force on Bea to stop her movement towards the Easter egg – walrus constellation, but also how it does not keep her there for very long.

In the excerpt above, the two entities (the exercise pamphlet and the nature-base) do not enforce each other, but rather compete with each other for the visitor's attention. They pull in different directions. This shows that the museum's mediating artefacts negotiate about the user's attention among themselves and with the exhibited objects. The nature-base steals the visitor from the exercise pamphlet for a moment, but not for long. When the visitor looks around, she sees the walrus, and this huge exhibited object turns her attention back to the exercise pamphlet and the task: has the walrus stolen an Easter egg?

The exercise pamphlet provides a specific kind of optic for the user. It directs the user's attention towards specific objects. The exercise pamphlet is linked to the Easter egg. The Easter egg and the exercise pamphlet mutually enforce each other. They are two associated entities that bring each other into the girl's sphere of attention. The exercise pamphlet and its related objects compete/negotiate with other entities for the user's attention. In the excerpt above, the exercise pamphlet-Easter egg constellation (and the purpose which is built into this constellation), are able to background the polar bear and the effects of climate change, as well as the information offered by nature-bases.

The digital nature-base may be entirely bypassed, for example, if the exercise pamphlet does not make an explicit reference to the computer, or it may be involved as a central part of solving the questions in the exercise pamphlet.

In the exercise pamphlets which Jakob and Torkild were using, mutually enforcing relations were established between the exercise pamphlet and the computer database. The computer database was explicitly made relevant by the exercise pamphlet.

This portrayal of how the *exercise pamphlet* is linked to other entities, says something about how the *digital nature-bases* participate in the visitor's encounter with the museum. The nature-bases are brought to the children's attention when questions are directed towards information, which may be found on the computers (audio 0028, 0029, 0030, 0031, 0032). 12-year old Peter sums it up when I ask him what he thinks about the nature-base: "Well, it's good to use if you have to answer these questions" (audio 0032). Peter judges the digital nature-base for its use-value. It is valuable when it helps him carry out the activity he is engaged in. It is valuable when it is made relevant by the exercise pamphlet.

How does the exercise pamphlet exert influence

In which manner does the exercise pamphlet (and its related entities) exert influence on people? This is one of the tricky discussions in the relationship between materiality and sociality: which causalities are at play and how is action determined? (Latour 2005).

Using actor network theory, the museum building as a whole may be seen as a network. The links between walls, flooring, stairs and ceilings are (relatively) stable. These entities do not move around (very much), and they create fairly predictable patterns of movement. People tend to walk through door openings, rather than through walls, for example. These artefacts, which are designed in a manner so that their interpretive flexibility (Gherardi and Nicolini 2003) is limited, have a tendency to produce specific effects in user's actions. If we look at the physical structure of the museum it seems appropriate to talk about relatively deterministic relations where materiality structures sociality.

The exercise pamphlet does not produce patterns of movement that are as predictable as the ones exerted by the solid entities of walls and flooring. The exercise pamphlets are artefacts with more open interpretive possibilities. They may be folded into airplanes. They may be thrown away. They may be disregarded in many ways. But they aren't.

The pamphlet does not exert as strong a prescriptive pattern on users as the solid structure of the building does, but nevertheless the pamphlet creates certain patterns of action. The exercise pamphlet has a force; it focuses attention and in this way envisions a certain horizon of possible actions. The exercise pamphlet in this sense shapes the visitor's seeing and doing of the exhibition. It and its aligned entities prescribe the way the exhibition is performed.

The exercise pamphlet to a large extent is acted upon in manners which are not entirely dissimilar to the sender's intention. This does not mean that there are not interesting issues to explore as regards differences in the perspective of sense-giver and sense-maker (Pratt and Rafaeli 2006). There are. Sense-makers (visitors) come across problems

in understanding the exercises. *What exactly does this mean? Where am I supposed to find this information?* But there still seems to be a balance, where the exercise pamphlets are 'good enough' in use, in museum visitor practice, to not be discarded.

Visitors perform the museum space with the exercise pamphlet as a central force of movement. The visitor performs the exhibition in accordance with the temporal and spatial order suggested by the exercise pamphlet. In actor network theory "networks and spaces are generated together" (Murdoch 1998, p. 360). Space is seen as an effect of associations between entities. Space is relational: space becomes a question of how network elements are related (Mol and Law, 1994, p.650).

Above are two examples of networked space. The physical structure of the museum – the links between all of the materials which it consists of – configures space, as does the exercise pamphlet: when the exercise pamphlet, user and other entities are in action together, they configure space. Both of these examples illustrate what Murdoch calls '*spaces of prescription*' (Murdoch 1998), but as indicated, the strength of the prescriptions are not identical. The prescriptions made by the exercise pamphlets are more subject to negotiation, than the prescriptions made by walls and flooring.

Users switch between different artefacts

The vision, actions and movements of visitors are not exclusively prescribed by exercise pamphlets. As is shown in the empirical excerpts, visitors also orient themselves towards objects which are not mentioned by the exercise pamphlets, and they interact with other mediating artefacts than the exercise pamphlets.

The connections which are established to and from the exercise pamphlet co-exist with other connections. Users relate to the museum exhibition through the mediating artefact of the exercise pamphlet, but they also do so by connecting themselves to other entities. In users' interactions with the museum exhibition, we can see the emergence of not only one network, but of several more or less stable alignments.

Users relate to distinct objects, and with this relating they contribute with action to distinct networks. In this manner distinct spatialities are enacted. The space which is produced by the exercise pamphlet co-exists with other spaces. Distinct configurations between users, mediating artefacts, exhibited animals and the material landscape of the exhibition produce distinct, overlapping spatialities.

This is made quite clear in the following interaction, where we again may see how the exercise pamphlet guides users, and this time in collective action, but also how Ane (12) and Sara (13) relate to the exhibition both with the exercise pamphlet and with a mobile phone camera.

Ane and Sara are at the museum with Ane's brother Johannes (9), and their mother and grandmother.

The two girls look at the picture on the phone. The boy looks at one of the animals on the podium. Sara moves her attention from the phone, moves towards Johannes who has an exercise pamphlet in his hands. Ane looks at the phone for a little longer, then takes the phone down and looks at the podium. Sara and Johannes move around the podium, Ane follows. Suddenly Johannes exclaims something, and moves forward at a high speed, with the exercise pamphlet raised in his hands. He has seen an animal with an Easter egg next to it. The two girls follow. Johannes uses the podium to lean the exercise board on, flips a page, says "which one is that one?" Sara looks over Johannes's shoulder at his exercise board, she then moves to the nature base right behind them. Ane is absorbed in her mobile phone.

(00:12:36)

Johannes looks at the exercise board, pointing to a picture, he says: "It's this one." Johannes is occupied with his exercise board, Ane with her mobile phone. Johannes flips one page forward, and one page back, then says: "we also have to find…" Ane looks at the exercise board, briefly, then looks back at her mobile phone. Johannes calls Sara, she comes over. Sara and Johannes move from the podium, go to the Arctic podium. Ane follows, steps in next to Sara. "I want to take a picture of that one" (Polar Wolf). Johannes leans over, looking at the exercise pamphlet. He uses the podium as a table. Ane takes off: "I'm gonna go take a picture of the hare." Sara bends over, also looks at the exercise pamphlet. Using his pencil, Johannes points to something on the podium. In one movement he flips the pages closed and stands up.

Ane has gone around to the other side of the podium, mobile phone in front of her. She says: "I've found some that have an Easter egg," she looks around, looks for the others, realizes they aren't there, moves quickly away from the podium, calls out: "Sara, I've found one that has an Easter egg," she goes back to the podium. Her mobile phone is in her hand, not in use right now, the others approach the podium, she points to the podium. Johannes says: "Where?" , "There", says Sara. Ane is oriented towards her mobile phone again. Johannes leans over on the podium, flips the pages, makes a mark, walks away. Ane bends over, photographs a small white fox. Sara looks at a wall-mounted screen. (00:14:32)

(video 008)

In this excerpt the visitors engage in interaction with different kinds of artefacts and these artefacts coexist as networks in action. Ane is engaged in two networks of action. She is primarily oriented towards her activity of photography and using her mobile phone camera as a way of connecting to the exhibited animals, but she is also loosely coupled to the activity which evolves around the object of the exercise pamphlet. Sara is carrying an exercise pamphlet in her hands, but she is not engaged in solving it. Instead she is engaged in interaction with two other portable artefacts: Johannes's exercise pamphlet and Ane's mobile phone camera. At this point the exercise pamphlet is primary in Johannes's performance of the exhibition, but a little while later, he gets dressed up in an animal costume and performs the exhibition in interaction with *that* portable artefact. Just like Jakob.

In these interactions the children have one artefact, which seems primary to them. The mobile phone is primary in Ane's actions. The exercise pamphlet is primary in Johannes's. But they also align themselves with the action nets which evolve from the objects which their relative carries. Ane randomly participates in Johannes's endeavour and vice versa. Sara participates in both modes of performing the exhibition (with an exercise pamphlet and with a mobile phone camera).

Shifting networks are multiple spatialities

The shifting interactions which users engage in may be seen as fluxes among and in loose networks. These are networks where the links between the participants are provisional and divergent. "The various components of the network continually re-negotiate with one another, form variable and revisable coalitions, and assume ever-changing shapes (Callon 1992)." (Murdoch 1998, p. 362).

The networks which users participate in are networks of variation and flux, and according to Murdoch (1998), these networks create spaces which are fluid, interactional and unstable. They create '*spaces of negotiation*'.

Following actor network theory these shifting interactions may be understood as shifting spatialities. The artefact and the visitor together perform a specific spatiality. The distinct artefacts bring distinct spatialities with them.

There are simultaneously multiple spatialities at play in users' performances of the exhibition. These multiple spatialities are made tangible when they are seen as the effects of distinct configurations of bodies, portable artefacts and material landscape (Haldrup 2006, Haldrup and Larsen 2006). The mobile phone camera and the animal costume are part of other networks than the ones which the exercise pamphlet participates in, and in this manner these two artefacts manifest other spatialities than those of the exercise pamphlets.

But why do the shifts occur? And what role do humans play in them?

Latour asserts that in order to understand social action, we have to include all participants. Latour argues that it must be quite fundamental in a social science to clarify the question of *who* and *what* participates in the action that we are trying to understand. This is an issue which must be thoroughly explored, "even though it might mean letting elements in which, for a lack of a better term, we would call *non-humans*." (Latour 2005, p. 72). Latour argues, "Anything that does modify a state of affairs by making a difference is an actor." (Latour 2005, p. 71).

The relevant question to ask about any actor is the following: "Does it make a difference in the course of some other agent's action or not?"(Latour 2005, p. 71). The answer to the simple question of whether the exercise pamphlet makes a difference is of course, *yes it does*. So following Latour, the exercise pamphlets are actors; they are active partici-

pants in the course of action. But does the user not also make a difference to the actions of the exercise pamphlet? And has the participation of the user been thoroughly explored?

What is the role of human attention?

There is an aspect of the shifting interactions which I find missing in the actor network vocabulary. When Bea switches her attention from polar bear to Easter egg, to nature-base, to walrus, to exercise pamphlet, these switches may be explored as network negotiations and as spaces of negotiation – as it is done above, but these switches may also be explored as shifts in *attention* and as a story of how *intention* is a strong force in the establishment of relations of action between heterogeneous entities.

Initially in this text we meet a boy who is dressed up as a fox. At a point he walks around in the exhibition, wearing his fox costume, solving exercises (audio 0013). The animal costume is on his body, but it is not being performed. When the boy shifts his attention and intention, action is channelled into relating to the exhibition with either the exercise pamphlet or the animal costume. Human awareness and intention seems to be central in the actions of these objects.

When the boy asks his older sister for help, she is absorbed in photography. She – in that moment – shifts her attention, clicks out of her performance and enters into his. She helps him solve the question that gives him trouble, and after that resumes her own photographically mediated performance of the exhibition.

Tension between human performance and the action of things

There is a tension between talking about *how humans perform an exhibition* and working with the actor network theoretical principles of symmetry and heterogeneity (where it is stressed that no *a priori* assumptions should be made as to who or what acts – as expressed by Latour in the quote above). John Law (2004) suggests the use of the word enactment instead of performance: "the term [enactment] is possibly preferable because performance has been widely used in ways that link it (…) to human conduct." (Law 2004, p. 159).

Crudely speaking actor network theory is not interested in paying special attention to humans. A critique of actor network theory is that in the chase for symmetry and heterogeneity the thorough examination of human actor's participation goes lacking. This sort of critique is raised by Pickering (1993), who suggests that intentionality may be the "key distinction between human and nonhuman entities."(Murdoch 1998, p.368). Murdoch raises the question "how far the symmetrical perspective offered by ANT can be integrated with a human centred analysis." (Murdoch 1998, p. 368).

These comments are echoed in the reflection that perhaps attention and intention are missing in the actor network inspired analysis. Human awareness and intention may be further explored as important forces in the establishing and breaking of relations between users, portable artefacts and the exhibition.

Summing up: The influence of artefacts is negotiated

The vocabulary found within actor network theory has been useful for showing how exercise pamphlets participate in the performance of the exhibition. It has demonstrated that exercise pamphlets guide and prescribe users' movements in the exhibition. It has shown how exercise pamphlets work through relations with other entities and thus form networks. Within an actor network analysis these networks are also spatial configurations. The spatialities which are performed with the exercise pamphlets co-exist with other spatialities.

The exercise pamphlet prescribes action, but the exercise pamphlet and the actions it prescribes are negotiated. The analysis thus shows a network where the links between the entities – human, technological, animal, etc. – are provisional and loose. They stabilize certain forms of action, but they are also ephemeral. Users do not only relate to the exhibition through the links which exercise pamphlets co-create. They also do so through links which are established to and with other mediating artefacts. Users switch between artefacts. These shifts may be understood as shifting networks and spatialities. The exhibition is performed as a series of both stabilizing and unstable, fluid and interactional networks. The exhibition is performed as several coexisting spatialities.

A theme which is not accounted for by the actor network analysis, but which may be important for understanding the negotiated manners in which artefacts participate in the performance of an exhibition, is the role of human awareness. Attention and intention are important forces in the establishing and breaking of relations between users, portable artefacts and the exhibition.

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Three challenges when designing for children's everyday digital literacy

Abstract

We use the concept of digital literacy to refer to people's competence of expressing themselves in computational form, and in this paper we specifically discuss the design of interactive technology aimed at letting children become digitally literate. A rarely discussed aspect of digital literacy in this respect concerns how it is supposed to take form in the context of improvised styles of use and interaction, resembling the kinds of activity commonly observed in kindergartens, school yards and centres for after-school activities. In such settings children often organize their own play activities, peers may go in and out of activities as they want, often without any necessary intervention by adult supervision. We align this kind of activity with the notion of 'casual leisure', and outline four basic challenges concerned with: a) a perspective on interaction, b) activity and context, c) the view of the user, and d) the character and role of the technology. We discuss these in relation to research attempting to design, evaluate, and make useful sense of children's digital literacy in such activity. Our analysis identifies the sources of these challenges as due to expressions of tension between play and learning, between designers and users and a general striving for 'hard fun'. The challenges and their consequences may be summarised as 1) the use of setting as allowing for spontaneous interactions, 2) the striving towards a participants' perspective, 3) the incorporation of offline and social aspects into the design, and 4) the balancing of challenge with the easy and the accessible.

KEYWORDS
Design perspectives • Digital literacy • Leisure • Play • Learning

Introduction

The notion of literacy has traditionally been used to describe people's communicative competencies through written language and the ability to read and write as a necessity for participating and taking part in society. With the development of digital media the notion of *digital literacy* has been proposed to involve an equally important ability in con-

temporary society. As discussed at a workshop on digital literacy; Interaction Design and Pedagogical Practice in Stockholm 2007, the notion of digital literacy suggests a very broad spectrum of understandings and usages. Notions such as simulation literacy, gaming literacy, online forum literacy and even Facebook literacy were discussed during the workshop in attempts to denote the multitude of specific meanings involved. This is due to the plasticity of the digital material and its virtually endless ability to represent and enable a range of different kinds of activities. Exploring digital literacy can therefore not be seen as a "remediation" (Bolter et al. 1999) of competences and skills developed with other kinds of media expressions. Instead, a whole new range of aspects specific to the digital media such as interactivity, dynamics and mobility are put to the fore.

The importance of digital literacy naturally holds a number of consequences and challenges for the educational system, but just as importantly also for almost all other social settings, as the use of digital artefacts is becoming an integral part of everyday social life and communication. In line with this development it has been argued that digital literacy will become increasingly important for future generations as computation becomes more and more embedded and ubiquitously integrated in our everyday environments (see e.g. diSessa 2000; Kelleher et al. 2007).

We use the notion of digital literacy to denote the ability to understand, and to make oneself understood through computational materials, for instance to create an animated game or to understand an interactive story created by a friend, or simply to engage in creative and playful text-messaging dialogues. Such media-specific aspects of usage and communication with digital media create new conditions and possibilities for researchers and practitioners with the ambition to understand and contribute to people's possibilities of expressing themselves with digital technologies. It should be noted that digital literacy in this sense should not to be mixed up with "computer literacy", which concerns the ability to use a personal computer. Rather, the notion that we propose involves a more fundamental engagement and understanding of the qualities and possibilities of computational materials.

One key characteristic of digital media is that they require mediation through digital devices upon which someone is expected to actively engage in order for the media to take form. Compared to traditional media forms, *designers* of such mediating devices thereby play a very important role in supporting digital literacy; by providing the hardware and software tools upon which such competences must be based. The purpose of this paper is to promote discussion of how constructivist and situated perspectives on action and learning could be given the place as foundational theory in such practical design work, aiming specifically at children's possibilities of expressing themselves in digital form in everyday casual use situations.

Based on discussions of currents trends in Human Computer Interaction (HCI), Interaction Design and Children (IDC), as well as in Computer Supported Collaborative Learning (CSCL), we outline four challenges that we believe need to be further addressed in

research, given the goal of designing interactive technologies that effectively may be appropriated by children to blend into their everyday practices, and thereby making them powerful vehicles for their own personal expressions. Especially, we bring in the notion of casual activity to emphasise how technology also needs to be designed for settings that are not primarily for work or learning. Bringing these challenges into discussion is primarily intended to promote conceptual awareness of how designers make use of notions of play and learning, and casual and serious activity, in the design of new technology.

Designing for digital literacy in casual settings

A common claim in research on technology targeted at children is that it should be grounded in children's everyday play practices, and how these are physically as well as socially manifested and organised (see e.g. Druin 1999). This is the case both for technology designed for specific educational settings as well as for more informal and open-ended activities. Based on such ambitions we draw on Robert Stebbins' (Stebbins 1997) work on leisure, emphasizing the difference between what he defines as serious, rule-based and well-structured games and activities, versus the broad range of more casual leisure activities. According to Stebbins' definition:

> "…casual leisure can be defined as immediately, intrinsically rewarding, relatively short-lived pleasurable activity requiring little or no special training to enjoy it. In broad, colloquial terms, it could serve as the scientific term for the practice of doing what comes naturally." (Stebbins 1997 p. 18)

In everyday interaction with and around technology, the casual dimension is one of the most significant. This is exemplified by patterns of watching television, listening to music, or the social use of mobile and online technologies. However, in relation to its prominent role in everyday settings, the methods used for designing and evaluating technologies aimed explicitly at such modes of usage are fairly sparse (see however e.g. Sengers et al. 2006). The casual dimension is of course extensively explored in the commercial world, but the relative negligence of this in technology-oriented research indicates that an increased research focus on the casual dimensions could contribute to a range of important understandings. Moreover, notions such as play and learning, as well as casual and serious technology use, involve conceptual dichotomies that may be difficult to combine and which therefore provide intriguing design challenges for the case of digital literacy.

When looking at the area of Interaction Design and Children, the research is almost exclusively aiming at the more 'serious' modes of playing within formal or semi-formal educational settings such as schools, museums and organised after-school clubs. Breaking away from such conventions may be a challenge in design, but also in the way we set up studies and analyse systems in use and estimating their social and educational value. Moreover, satisfying a research goal articulated in terms of 'learning outcomes' or 'pro-

ductive conversations' sometimes obstructs the study of activities that allow for self-driven, spontaneous activity.

Design Challenges

The challenges that we propose are grounded in two key trends in current HCI research. Firstly, we draw on phenomenological and ethnomethodological approaches, which have a fundamental aim of overcoming dualist conceptions of knowledge and action. This relates to the recent focus within HCI as well as in CSCL to increasingly turn attention to the study of practices in natural and casual use settings. Since Lucy Suchman's (1987) critical analysis of some of the basic assumptions on how the concept of interaction has been applied in HCI and artificial intelligence (AI), a practice-oriented perspective has become increasingly called for, more recently illustrated through e.g. Dourish's (2001) work on embodied interaction and Jaccuchi's work on the concept of performance (Jacucci 2004).

Secondly, our work follows the trend of conceptualizing HCI as a design-oriented field of study, (Löwgren et al. 2004; Bødker 2006; Vetting Wolf et al. 2006), drawing on e.g. Donald Schön's (1983) account of *reflective practice* as an essential aspect of professional work. This includes the reaction against goal-oriented problem-solving methods, emphasising instead ludic and experiential dimensions (McCarthy et al. 2004).

We have compiled our understanding of the consequences of these trends into four basic challenges for research attempting to design, evaluate and make useful sense of technology that aims to support what we find to be at the core of digital literacy for children, i.e. their possibilities of expressing themselves personally and socially. These challenges are discussed with reference to research in Interaction Design and Children and its overall tendency to degrade casual aspects of interaction in favour of institutionalised and formal use of technology. The four challenges that we present are organised around the fundamental attitude that all design work inevitably reflects, in reference to: a) perspective on interaction, b) activity and context, c) the view of the user, and d) the character and role of the technology.

Interaction: Acknowledging All Interaction

A general development in contemporary social, cognitive and educational sciences is the so called 'practice turn' in which embodied and social aspects of human activity are put to the fore (Schatzki et al. 2001). Similar strands of development can be found in notions of situated learning and cognitive apprenticeship (Lave et al. 1991) as well as in theoretical perspectives explored in design work where the inevitable intertwinement of play and learning is taken as a starting point (Papert 1980; Jonassen et al. 2000; Paiva et al. 2002; Zuckerman et al. 2005). Fundamental to these perspectives is a shift in focus from considering "processes of individual cognition" as basic, to considering processes of "interac-

tions people have with each other and with the material and representational resources in their environment" as basic (Greeno 1997, p15).

A core consequence of this perspective on interaction, which has been highlighted for instance in Dourish's work on embodied interaction (Dourish 2001), concerns how some of the most important aspects of a shared activity lie outside of the actual interaction with a computational system. The expanded space for using technology provided by the physical and social context includes many important issues that are central to everyday casual interactions, such as ownership, attachment and personalisation. Especially in children's play, an important aspect concerns the ability for participants to socially configure the 'rules' of the activity in which the technology is taken into use, and also to physically arrange their interactive resources. This suggests that we need to consider both interaction with the system and interaction between participants around a system in our design efforts.

In HCI, the practice-oriented perspectives have still been most influential in empirical analyses of interaction with new technology. The impact of these theories for designers still leaves issues open for exploration. An example of this is the present concern of designing for collaboration, sharing and social interaction, which is generally viewed as a new and difficult step to take from previously individually-oriented design perspectives. The dominance of the individual perspectives is illustrated for instance by the sole existence of research fields such as CSCW and CSCL that specifically address collaborative and social dimensions of design and use, rather than viewing these as central to HCI in general (see also Rogers' (Rogers 2004) review of the role of theory in interaction design practice).

This view of social and shareable use as a new and more difficult design problem (than individual use) is fundamentally based on it being positioned within the theoretical legacy of individually designed user interfaces. This suggests a need to reformulate the design space so that social and collaborative aspects are not viewed as extraordinary design problems, but rather as the basic ones. To pursue such a commitment naturally involves a number of challenges, theoretical as well as practical. However, as discussed e.g. by (Fernaeus et al. 2006), this could be viewed as primarily a conceptual task – shifting from an information-processing perspective to a more action-centric one (Heath et al. 2000; Dourish 2001).

Activity and Context: Avoiding pre-imposed structure

Ethnographic and ethnomethodological studies in schoolyards and kindergarten settings have identified a number of aspects that characterize children's 'natural' play activities. Typical examples include a large amount of spontaneous, situated action, social improvisations and a constant flow of setting up and reconfiguring the rules for participating in and contributing to the activity (e.g. Goodwin 2000). Moreover, children often move in and out of, and between different activities, and play tools are commonly transferred physically as well as imaginatively between different play contexts (Smith 1994; Wyeth 2006).

Combining findings from such studies with the ambition to validate the outcomes through some well-established measure may be difficult, especially in educational settings. On the other hand, children's everyday play and general social interaction requires no specific structure, and yet it is claimed to be one of the most important contexts for learning and development (Vygotsky 1976; Smith 1994). We see no reason to suspect that computer-mediated casual play would not have similar properties. This implies that an equally valid measure for successful educational technology could be that the children engage in an activity that resembles a conventional social play practice.

However, when looking at the field of research addressing children's digital literacy, almost all publications and research projects display an active commitment towards what elsewhere has been called 'corrective technologies', i.e. technologies with the purpose of supporting interactions in a manner that make them more productive, more learnable, or more efficient within specific domains. Although this is of course often worthwhile, especially in educational contexts, 'corrective technology' may not always be what users will actually be willing to use.

This challenge thereby concerns how children's everyday play and learning is not always supported by a formal institutional system of education and guidance. It may therefore not fit naturally into the well-organized and structured means that research in interaction design commonly assumes, which is usually framed as targeting an existing 'problem' that needs adjustment. When the goal is to support deliberate, spontaneous and user driven interaction, we need to instead put increased effort into considering how the designs may be able to leave the usage of a particular technology open for improvised and creative play. This is not meant as a proposal to stop developing technologies explicitly for formal learning settings, but rather a way of cherishing casualness as a central dimension of human activity that we must find ways to more productively incorporate in HCI research.

The User: Accepting the participants' perspective

A third challenge that is brought to the fore by looking at digital literacy in casual settings is what we call a "participants' perspective" on action and interaction with technology. The participant's perspective emphasises that designers and analysts should attempt to understand how an activity in which technology is used is viewed by the participants – not to search for evidence that may serve to label the activity based on pre-imposed categories of what is wished for or expected. From such a viewpoint it is basically irrelevant whether the researcher categorizes an activity as play, learning, entertainment or something else. Instead it is argued that analyses should attempt to document how the participants go about doing and organizing the activity, e.g. what aspects of the technology they are oriented towards, what they make central and peripheral, and how they make the activity meaningful for themselves and their peers (Heath and Luff 2000).

A common argument in the design of tangible toys is for instance that a physical manifestation allows users to make use of experiences from interaction with other everyday objects, allowing the resources to blend into existing activities in a natural way. An interactive tabletop may be usable as an ordinary table, a classic PC keyboard may be used by several children at the same time, and games, software and mobile technologies are constantly observed to be appropriated by children in a range of unintended ways. This aspect of interactive technology draws attention to the quality of also being possible to use for other "non-intended" kinds of interactions.

This challenge might primarily be thought of as concerned with evaluation issues. However, seeking a participants' perspective is of equal importance for designers in order to avoid being directed too strongly towards fulfilling goals that are not inline with their users'. This again relates to the fundamental opposition in research on children's technology on how to relate to design goals in terms of learning, versus more general goals for children's creative, joyful and improvised activity. Balancing between these two sets of goals can be challenging, and within research areas such as CSCL and IDC, the former often stands in the way of the latter.

From a design-oriented perspective, Sengers and Gaver (2006) have conceptualized this challenge as "staying open to interpretation", thereby suggesting that designers should not have only one preferred interpretation in mind for how a system should be taken into use. Instead users should be allowed to engage in multiple possible interpretations of a technology. Such openness puts designers in a new position in the design process in terms of how to set up goals for their work and also how they orient themselves towards these goals. The same goes for evaluation. What should be evaluated and what is a successful design becomes less clear cut when there is no appropriate user interpretation to search for.

Aspects related to what children think of new systems, and how they would evaluate them are matters that are commonly discussed and addressed in research on interaction design and children. However, apart from participatory design projects, e.g., Druin et al. (2002), Ramachandran et al. (2007), Moraveji et al. (2007), user studies are usually designed as classic evaluations, aiming to assess the technology as useful for the children based on measures such as efficiency, learning outcomes and even the speed of mouse clicking (Pawar et al. 2007). The meaning that children make, their narrative, social and emotional engagement, and how they chose to appropriate the technology into their everyday activities, is generally less discussed (see however (Wyeth 2007) and (Hutchinson et al. 2006)).

This in no way means that the studies, or the systems presented, are not important for the children using them. Neither does it suggest that the literacy developed in the use of these systems will not go beyond the settings that are studied. Rather it suggests that the genre forces researchers to take on a perspective that brings up pre-specified qualities, rather than showing openness to the meaning that users may make of the system. A greater sensitivity to

what users interpreted the systems to be good for would probably have put forward other values, leading to an increased understanding of their view of the use qualities.

Character of the Technology: Let easy do it

Of particular relevance to the domain of children's technology is the relationship between the classic values of HCI (such as ease of use) and more recent developments in areas studying experiential aspects such as game play and flow, where virtually contradicting values are emphasized (such as challenge and competition).

This particular aspect has been discussed widely, and a common argument has been that technologies for children must not be trivial, since they would then take away the 'fun' of playing (Papert 1998). In line with the classic 'pianos not stereos' (Resnick et al. 1996) argument, research into children's technology often acknowledges the complex before the simple, the difficult before the easy and the serious before the casual. What has rarely been discussed is how casual play may also be an enjoyable, and in fact more common, activity in children's being with technology. If we look at many of the everyday artefacts that we have around us, collaborative, social and casual use is seldom a problem or something that occurs only occasionally. Quite the contrary, such usages are often the natural mode of being with artefacts. This includes how activities tend to develop on the spot, by the participants themselves, without assumptions of a priori commitments of what exactly should be completed or performed. The observation that casual activity does not result in the same *kinds* of engagement does not necessarily mean that it is less important, especially since the same activity may shift between casual and serious at different stages and by different participants.

We suggest an approach that appreciates stereos *and* pianos, in particular since children's use of technology more often has the character of a combination of serious and casual activity, apparent for instance in the extensive use of technologies such as television, music players, video games, instant messaging and online communities. Despite many strong arguments for more complex technologies (e.g. logo programming), this suggests that it is the easy that is in fact mostly taken into use. Hence, even though challenge can be a strong motivating factor, designers should consider the actions one chooses to make easy and accessible.

Moreover, when looking at systems developed specifically for children, the technology is almost exclusively argued as aiming for formal or semi-formal educational settings such as schools, museums and organised after-school clubs. This could be interpreted as 'child-engineering' as initially defined (Papert 1980) have lost some of its status in research as being less about designing for children and what they will deliberately and actually use, to instead aiming at what teachers and parents may expect or want in their practices. This is even though common knowledge, as well as empirical studies (see e.g. Jarkievich et al. 2008), show that children in unsupervised play settings are often well

equipped to bring new technology into their activities, and that they in these settings freely select which of the available toys, technologies, and online resources to use. This double-faced situation suggests that increased efforts into how to design, evaluate and look upon technology aiming for more casual settings may result in educational technology would that stand a better chance of being effectively incorporated into existing and future practices of digital literacy.

Conclusion

Given that expressions in digital form are important not only in formal education, we need to develop design approaches to also support digital literacy in other settings and contexts. When designing such technology for children, and for these technologies to be integrated in everyday play and learning practices, we argue that an increased effort should be put into supporting personal expressions and everyday social interactions.

A fundamental aspect of most human activity is the ability to communicate and express one's ideas and knowledge to others. While people extensively express themselves and communicate through language, other forms of expression are just as important, such as making pictures, performing physically or using music. Different media are also appropriate for expressing different things, just as oral and written language are appropriate for different kinds of expression. It may for instance be easier to illustrate dynamic processes through a medium that is not static, while static media formats may provide a better overview. It is often argued that skills in utilising the properties of different forms of media expressions and their semiotic possibilities become especially important as a growing part of the media content around us are made with digital tools, and the ability to produce own such media, such as mobile content, interactive applications, and games, are becoming new important aspects of everyday learning and communication. New ways for people to express themselves through digital media are constantly being developed, and in accordance with this, expanded understandings regarding the type of situations where people may find such tools, resources and practices useful are necessary.

We have presented four theoretically grounded challenges involved in incorporating a practice-oriented perspective into the current discourse of interactive systems targeted at children in relation to the notion of digital literacy.

Just as literacy in the traditional sense involves a wide range of things that people can do through the use of written language, from defining the formal rules of a football game to playing with words in a child's book, our understanding and appreciation of digital literacy should incorporate a similar richness in what can be achieved through digital technology.

Designing interactive technology for children that addresses these different dimensions of digital literacy is then not only a matter of supporting playful learning in the form of

structure, challenge and bodily forms of interaction. Equally important is to include the possibility to participate socially, from multiple perspectives, at different levels of engagement, and without requirements for a specific course of action. Note that our focus on the casual dimension is not intended as a call for abandoning the design of more structured forms of interaction. Rather this work is intended to promote design thinking oriented towards technologies that may leverage children's possibilities for expressing themselves through digital technologies. Much current research on children's technology is implicitly based on such assumptions, especially through the increased focus on systems that aim at supporting collaborative and more physical forms of interaction (Crook 1997; Price et al. 2004). However, we argue that a more foundational approach to these challenges needs to be further developed.

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Educating the Theorist-Practitioner

Fostering Digital Competence with Interactive Digital Media Research Studios

Abstract

There are very real opportunities for innovative research and development in the emerging field of interactive digital media: new forms of entertainment, education, social services, and the like. But where will the innovators actually come from? For all the popular rhetoric in the world today about "educating a new generation of innovators," for the most part the institutional structures of higher education still look as if they are either training students to be traditional scholars of new media – or simply training them to be skilled developers of existing products and applications (e.g., conventional computer games). This paper argues that university-based interactive digital media education needs to train a different kind of digital literacy and competence: that of a theorist-practitioner. And such an education requires a digital *research* studio focus.

1. Introduction

Although I have a research and industry background in the design of advanced media technologies, in recent years I have also been teaching university courses in different parts of the world. In the process of training students to design innovative digital technologies, there are a number of interdisciplinary challenges that arise.

Consider the following situation from the university course I teach in game design. One of the design problems is to make a computer game automatically increase the game-play difficulty based on player performance. This is a well-known technique for having games automatically adapt to players. In *Tetris*, for example, the speed of the falling blocks is automatically increased as the player succeeds at clearing more and more blocks. For some things, it is relatively easy to determine "what makes something more difficult" – it can involve an increase in speed (or quantity) or a reduction in size. In other cases it is more challenging to identify what makes something more difficult; what makes one maze or logic puzzle harder than another?

However, even the "easy" design options raise interesting questions and challenges. Recently, one of the student teams was working on the design of its game. In the game, the goal was to shoot and hit falling targets. They were considering two different ways they could make the game difficulty increase automatically: increase the speed of the falling targets – or decrease their size. As part of their discussions they were also asking people to playtest their prototype, discussing the alternatives with the players, and so on. Ultimately, they decided to have the game increase in difficulty by having the targets fall faster. Their reason: players seemed to find this kind of difficulty-increase *more enjoyable* than the alternative.

This is an interesting hypothesis. Is it correct? How can we test it? Will the results of such tests suggest other important design rules or heuristics? Can we use such insights to identify other game parameters that make games more interesting or enjoyable? Traditional art training might help students to *make* things that are engaging, but it does not typically train them to pursue such questions. On the other hand, although conventional computer science helps prepare students to specify requirements, create an efficient implementation, and the like, it rarely has much to say about how to make products that are emotionally engaging.

This story highlights a number of challenging issues about the relationship between theory and practice, about our failure to adequately train university students for existing and emerging research and industry opportunities, and about even larger opportunities that *could* be identified and developed if the appropriate kinds of training existed.

Contemporary interactive media are becoming more complex and are being designed to support a wider range of activities than ever before. Such media support artists, gamers and researchers – people who have different goals, different ways of working and playing and different needs. Furthermore, depending on the context, people expect interactive media to function as anything from intelligent servants when booking flights to intelligent opponents in online games. This raises a number of foundational design questions that draw on such diverse fields as cognitive science, media studies, computer science and engineering, and art/design theory.

There are very real opportunities for innovative research and development in the emerging field of interactive digital media: new forms of entertainment, education, social services, and the like. But where will the innovators actually come from? For all the popular rhetoric in the world today about "educating a new generation of innovators," the institutional structures still look as if they are either training students to be traditional scholars of new media – or simply training them to be skilled developers of existing products and applications (e.g., conventional computer games).

Conventional economic wisdom currently argues that wealthy nations are transitioning to economies based on "creativity" while manufacturing/implementation is migrating (being "outsourced") to developing nations. To the extent that this is true, there is something paradoxical about a manufacturing model of education serving as a basis for

training "creative industry" scholars, engineers and designers. Although the model of "students coming off an educational assembly line" may be reasonably successful in the case of training students to work in well-established fields creating known products and services, it seems quite problematic for preparing students for their roles in a rapidly-changing world of innovation. There will certainly be creative jobs analogous to established vocations such as, say, literary criticism or animation or software engineering. But since we know precious little about how to design engaging interactive *experiences*, there is tremendous opportunity in "inventing the future" of interactive digital media – not just the technical infrastructure, but the media/technology that *meets the end-user*.

Is there demand? Indeed, there is tremendous unfulfilled demand from students, industry and the research community. In our experience, students are deeply frustrated when they must choose between, say, a computer science education (with a smattering of interactive media lectures or courses) or an arts/humanities education (with barely a smattering of technical lectures or courses). Likewise, research and industry are desperate for individuals who have a combination of skills and experience – not just "designers who know how to *talk* to programmers" and vice versa.

The needs of computer-game design, to take just one example, challenge a number of educational traditions and assumptions about the division between academic scholarship, vocational "skills" and tacit artistic expertise. There are, of course, scholarly courses on game studies, vocational programmes to prepare individuals for jobs in the game industry, and so on. But there is an alternative: a *theorist-practitioner* approach to interactive media design education. Such an approach is an alternative to both "the main purpose of practice is to make theory more concrete" and "the main purpose of theory is to inform practice." The theorist practitioner approach is one that combines the development of new theory with the creation of innovative works.

2. Why isn't this problem being addressed?

One of the biggest barriers to addressing this problem is the institutionalized Balkanization of formal education.

To be sure, there is something of a tradition in academia of letting students take (a few) applied courses to make the (important) theory concrete. And there is a tradition of arguing for the importance of theory in the training of skilled professionals. And certainly, art schools have invoked theory and more scholarly study in the form of anatomy, mathematics, and the like. However, there is a deep division that still persists between scholarship, vocational training and the creation of engaging and meaningful artifacts/experiences. Such divisions manifest themselves in various forms of Balkanized education: divisions between universities as "centers of scholarship", trade schools as centers of vocational training and art schools as centers of "art production." Such divisions and antagonisms even exist bet-

ween faculties within the same university, where scholarly subjects are opposed to applied subjects (e.g. computer science, engineering, medicine, architecture).

To give one example, "human computer interaction" (HCI) is an important field that has emerged over the last 20 years. And yet, even today, there is utter confusion and chaos about "where it belongs" in a university. Should it be in a humanities faculty (*human*-computer interaction) or in computer science (human-*computer* interaction). The dilemma is so real that many universities put it in *both* (and then endure endless turf-wars between the two). And since such programmes are not actually inter-disciplinary, they wind up discouraging or rejecting students who are genuinely interested in combining, say, programming with the design of innovative end-user products and services.

The particular example of HCI is just one of the more general cases: the requirements for developing engaging and important *end-user* interactive technologies requires a combination of skills and interests that cannot be adequately addressed by the current separation of scholarship/theory, design/implementation "skills" and fine art techniques. To give one concrete example: what kind of education currently prepares people to invent new attractions for amusement parks? This topic is often deemed "conceptually uninteresting" for university education, too "psychological" or "high level" for vocational schools and polytechnics and too "concerned with research about what the audience wants" for many art schools.

This Balkanization is not just institutionalized by tradition and inclination, but also by funding and government-level policy decisions. Such agencies "naturally" view universities as the source of scholars, polytechnics as the source of skilled technicians and art/design schools as the source of people who "make things that engage people".

And the loss is not just in the form of amusement park attractions, but consists of countless other emerging (and yet-to-be identified) possibilities that include interactive digital media systems that automatically generate innovative entertainment, art, education and health-care.

3. What We Could Do

This paper argues for the importance of the theorist-practitioner. Readers familiar with the work of Donald Schon will recognize the allusion to his concept of the "reflective practitioner" [Schon, 1983, Schon, 1987a]. Schon argued that practitioners should (and do) "reflect" on their practice. That is, skilled activity is not simply some vocational execution of learned skills, but involves complex forms of reflection, hypothesis-formation, modeling, and the like.

...reflection-in-action ...involves a surprise, a response to surprise by thought turning back on itself, thinking what we're doing as we do it, setting the problem of the situation anew, conducting an action experiment on the spot by which we seek to solve the new

problems we've set, an experiment in which we test both our new way of seeing the situation, and also try to change that situation for the better [Schon, 1987b].

For a variety of reasons, Schon was criticizing what he considered academia's excessive emphasis on a particular (positivist) model of "theory." This particular notion of theory is one inherited from the hard sciences, where the emphasis is on generality. But whereas greater generality is a sign of success in the hard sciences, it is often at odds with professional needs and interests. Hence the ongoing tension between academic and professional views on theory and knowledge.

It may seem as if there is a difference between the model of the reflective practitioner and the theorist-practitioner. But actually, the concept of the theorist-practitioner seems quite resonant with Schon's model in that it emphasizes the value of particular *kinds* of theory and knowledge that are often not appreciated or recognized as such in academia: *design* theory and knowledge. And there is a desperate need to provide suitable educational opportunities for such theorist-practitioners.

There are a number of examples that are typically invoked as models of such education (e.g. Vkhutemas/Vkhutein, the Bauhaus, the Ulm School, the MIT Media Laboratory). But for all their pioneering efforts, none of these actually tried to seriously engage with a circulation between theory creation and innovation practice. The Bauhaus and the Ulm School, for example, each contributed to an enlarged notion of design for a mechanical age – and each proposed pedagogical innovations in this regard [Wick, 2000, Museum, 2003]. But although many of the artists and designers who taught at these institutions circulated between the development of art/design theory and the creation of works, this circulation was not part of the core of the pedagogy. In other words, it seems that mostly it was the *teacher-artists* who were working through new theoretical concepts (as opposed to nurturing this in students).

Indeed, perhaps the best examples are elsewhere. The Polish Laboratory Theatre, for example, investigated the relationship between performer and audience by constantly circulating between the creation of theatre productions and the development of innovative performance theory [Grotowski, 1975]. Similarly, the work of architect Christopher Alexander is an ongoing circulation between the creation of actual architectural structures and the development of a new theory of architectural design [Alexander, 1987]. Some of the early work of architect William Mitchell also provides a good example of innovating in design theory and the development of new architectural forms [Mitchell, 1990]. And computer scientist Terry Winograd has been arguing for a "design perspective" in software development [Winograd, 1996] – one that keeps the focus clearly on such issues as, "how does the way that you build it interact with the way it will be experienced and used?" [Winograd, 2000].

These are not examples of "learning theory to be a better practitioner", but rather learning how to use theory to innovate in practice and how to use the results of practice to inform advances in theory.

4. What Will It Take?

To address this will require at least three kinds of effort. First, effort to overcome "disciplinary Balkanization": the development of institutional structures that make it possible for the creation of truly new and interdisciplinary forms of education. Second, the development of *digital research studio* programmes for interactive digital media. And third, an honest re-appraisal and redesign of institutional structure/requirements in the light of the realities of such research studio programmes.

4.1 Beyond Disciplinary Balkanization

We have already noted the traditional battle between "scholastic" focus and (mere) training in "skills." This separation is especially problematic when interactive media are designed to support human goals. Traditionally, computational media supported such things as *calculations* (census, airplane trajectories, finance). In recent years, they support a much broader range: finding information, booking/purchasing, playing games, creating art, modeling phenomena, supporting learning, and the like.

It is rare for courses to explore the interaction and potential synthesis of concepts and theories. In particular, to the extent such synthesis is attempted, these are often half-hearted extensions of arts/humanities subjects (in the direction of technology) or computer science subjects (in the direction of arts/humanities). To take one example of potential synergy in the field of interactive digital media, the coverage of computational concepts is often unsuitable for both arts/humanities students *and* (surprisingly) for computer science students.

There is an assumption that "introductory" courses can be designed and run independently of any concern for the particulars of students. An introductory programming course, for example, will be radically different if the goal is to prepare students for further work on inventing computational forms of entertainment rather than, say, implementing database-driven Web sites. The required computational knowledge and skills may *look* the same from the perspective of a computer science faculty, but they look very different for students with background in the arts who want to learn to work with computer programming as an expressive medium analogous to paint or clay. (And such courses look very different for a computer science student who wants to learn about computational techniques that are relevant to the specifics of end-user interactive media.) Standard computer science programming examples and exercises assume a particular background – and a particular future of training and interest. The same argument can be made for an introductory art course; it looks very different if the students are humanities students who plan to become critics or theorists – or if the students are computer scientists who want to learn a new set of aesthetic concepts and methods of evaluation for the practice of creating interactive/digital art. Programming students who take art appreciation modules are often frustrated when they do not learn much about how to *make* things that

have particular aesthetics – nor even much about how to *evaluate* works of art in ways that pertain to then *representing that knowledge computationally*.

Given such student concerns, it is simply heartbreaking when brave individuals from one faculty or another try to address this student-need – and are vetoed by a "competing" faculty with an explanation to the effect that "if any faculty will teach that subject, we will teach it – but we will never teach it". Ultimately, the losers in this all-too-common scenario are the students, the interested faculty members, the research community, industry, and, yes, society at large.

4.2 Beyond the Studio Model

One could argue that the issues being raised here are already addressed by a "studio" (or "lab") approach to digital art/design. But one aspect of this disciplinary Balkanization is the assumption that universities (largely) train students for further participation in research – and art/design schools prepare students to work as practicing artists/designers. This ignores the very real need for interactive digital media *research* – so, it excludes the undergraduate *preparation* for such things.

One might also argue that theory is already taught in the context of industrial design. But such theory is typically theory in the service of a particular kind of practice; it is not about how practice can inform the development of new design theory. What is needed is a practice-based approach to design education that nonetheless emphasizes understanding and *developing* theory – rather than simple "skill training."

A digital research studio would help students develop experience inventing, managing and evaluating their own work. Such work would involve project-based team-work with the right balance of rigor and creativity. For project-based courses, it is not usually appropriate to have some strictly defined goals, but rather to provide broad but clear constraints, regular feedback and distinct challenges that help students address issues they may not have considered – and even to arrive at insights and solutions of their own.

Students would work in small teams towards a final project – and each team would be required to submit weekly deliverables that build towards the final work. This project-work would involve all the aspects of any research/development project: identification of suitable focus (problem, target user-group, etc.), requirements gathering, prototyping and evaluation. Along the way, they would read relevant literature, study examples of related work, learn research and evaluation methods and discuss various ways to analyze and apply insights to the ongoing project-work. This would also involve collective discussions and analysis of student work which would allow students to be in the role of both creating and critiquing work. Broadly stated, by the end of such an education, students will know how to engage in the process of inventing, creating and evaluating something new and valuable – and will know how to work effectively with others to do this. Further, they should have some appreciation of how their work fits in the context of work done by others on similar topics.

Of course, in many ways this sounds similar to project-oriented courses in computer science, engineering or the arts/humanities. There are, for example, studio-based courses where artists learn many tacit skills for the creation of engaging artifacts – and similarly, there are lab-based courses where computer scientists and engineers develop the skills to apply specific techniques to the solution of particular kinds of problems. But how can we train students to, for example, invent an appealing and appropriate game that helps researchers understand the spread of infectious diseases in real time? The claim here is that we need something quite new: a studio-based focus on *design innovation in end-user oriented interactive digital media*.

4.3 Re-evaluating Education

The existing model of university structure is largely unchanged from the European model of the 1800s. It still assumes that such education is largely in the form of a lecturer speaking in front of a large auditorium of students who will then read additional works and write essays. The difficulties engendered by these assumptions are widely discussed elsewhere, but it is worth highlighting two problematic consequences specific to team-based project-oriented interactive digital media education: the problem of *scale* and the problem of *process*.

Project and studio-based education raises particular kinds of challenges, whether such courses are in computer science or in the arts. The assumption behind such education is that much of the professional-life is project-based, involves collaborative work and relies on disciplined habits of work as much as particular individual skills and knowledge.

For a traditional lecture model, adding more students has almost no impact on the teacher (especially if this is combined with multiple-choice exam questions that can be automatically marked). It is just as easy to lecture to 300 students as it is to lecture to 100 students. This is the essence of manufacturing optimization; from the perspective of the university, it just makes good economic sense to increase the scale. But if there is a switch to project-based team-work, this model is not just "more costly", it is *fundamentally wrong*. As everyone knows who has ever managed a group of people, the *management requirements increase logarithmically as a function of the number of people involved*. It is, in fact, the opposite of "adding *many* more students only requires a *few* more resources"; for courses that involve teams and projects, adding a *few* more students requires *many* more resources.

Furthermore, team-based project-oriented work needs to promote good practice, not just good results. For example, in professional life it is very important to make *regular progress* – rather than try to "cram it all in at the end." But project-based pedagogy that emphasizes *process* runs into problems in an educational model premised on such things as "final exams." It is not merely that the examination model shifts to such things as "continual assessment," it raises problems about what it means to do "make up exams." In

other words, in the traditional university tradition (especially in Europe), the model of what it means to "pass" a course is to *pass the final exam*. Students do not need to attend the lectures or otherwise interact with other students to pass the course. Indeed, there are *regularly scheduled final exams* for each course – and if a student does not succeed during one of these exams the student may try again later. This may be well and good for a course where the evidence of successful learning can be in the form of a several-hour demonstration. It is less tenable where the "demonstration" is in the form of such ongoing things as submitting regular deliverables, meeting deadlines, adjusting to unexpected project-events, and the like. How can one possibly structure a several-hour final examination for a student that is intended to be comparable to the efforts of a student on a team-based project during a three month-period?

These issues compound the need for a fundamental re-examination of university structure in the light of the needs of emerging industries and educational requirements.

5. Conclusion

This paper began by sketching a scenario in which particular kinds of design problems arise. Students need opportunities to raise such questions – and support to be able to discover and invent the answers to them. But the needs are not simply restricted to the creation of new kinds of courses. This needs to be part of a larger activity in which there is a circularity between research and education, one in which students participate in both. Students can – and should – be included in the development of new technologies and theories. And the results of such research can and should feed back into the courses of their fellow students.

We should create interactive digital media research studios to support a new form of digital apprenticeship: something that supports the legitimate participation of student theorist-practitioners who circulate between the creation of working artifacts and the creation of theories about the design of such artifacts.

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