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CSC*: Computer Supported Collaborative Work, Learning, and Play

Michael B. Twidale
GSLIS
University of Illinois at Urbana-Champaign
twidale@uiuc.edu

X. Christine Wang
Graduate School of Education, University at Buffalo, SUNY
wangxc@buffalo.edu

D. Michelle Hinn
Educational Psychology
University of Illinois at Urbana-Champaign
hinn@uiuc.edu

Abstract. The authors combine their experiences in three independent studies of informal learning in the contexts of the workplace, school and leisure. They uncover aspects of collaborative work, learning and play involving the use of different learning and teaching techniques, and supported by appropriations of the regular use of the applications. The importance of play, both for application learning and innovative use in different settings, including the workplace, is examined. The implications of explicitly supporting ad hoc collaborative approaches to learning how to use a computer application are explored.

Keywords: collaborative help-giving, informal learning, workplace learning, play, CSCW

INTRODUCTION

Computer supported collaborative learning is not just applicable to formal school-based hour-long lessons. CSCL researchers can also inform the design and support of more ad-hoc collaborative interactions interleaved with other aspects of learning, work or play. This paper is the result of the three authors discovering quite by chance that they had each independently explored aspects of informal learning in three independent studies. After the studies had been completed and our data had been analyzed for our own independent purposes, we met together over several months, sharing and reflecting on our separate approaches, analyses, findings and interpretations. We found some intriguing parallels in the kinds of interaction observed in very different use contexts, as well as many differences, and this has provoked us to reconsider what we might investigate in the future in more depth in our respective contexts of interest. In this paper we focus on exploring the ways in which people collaboratively learn application use, the pedagogic techniques employed, and the way that the system in use is appropriated and adapted to support various kinds of activity. We believe an examination of application learning in different contexts can provide a useful cross-fertilization of ideas for the building in of functionalities and interfaces to afford different learning and teaching techniques. By the happenstance of independently having chosen to study contexts that can loosely be described as work, learning and play, we began to think about different pairings of the three concepts. In particular, we consider the way that the applications are used and appropriated in ways that their designers had not intended, particularly to allow more people to use them as a way of facilitating learning. We also consider the role that play may take in supporting learning, creativity and innovative application use, not just for young children, and not just in leisure or kindergarten or elementary school settings but also by adults in various settings, even including the workplace.

THREE DIFFERENT STUDIES OF COLLABORATIVE INTERACTION

The three studies had been developed independently using different methodologies and to some extent informed by different intellectual traditions (educational theory, psychology and computer science, with a further influence of ethnography on all three). It was only afterwards that the authors began to compare notes. We must emphasize the lack of consistency in approach between the three studies, caused by their independent nature. Although this weakens the opportunity for systematic comparisons, we believe it serves to reinforce the triangulation of the individual findings, outlined here and elaborated in separate papers. In all three studies we find learning embedded in other activities. In the workplace, the main focus of people is to get their work tasks done, but when problems are encountered, people ask colleagues for help and advice. In the case of playing a competitive console game, the main focus is to have an enjoyable time by competing, but if one's opponent is far

less skilled than you are, you may need to help them learn enough to be able to have an enjoyable game. In interacting with peers and waiting one's turn to play a game in a classroom, children seem compelled to help each other improve.

Computer Supported Collaborative Play (CSCP): Students Playing Console Games

Twenty-four participants were recruited from a university educational psychology subject pool. Participants were asked to bring either one or two same-sex friends to the study. There were 8 male and 8 female dyad and 4 male and 4 female triad sessions. In each session participant groups played two different console games Tennis 2K2, a sports game, and Halo, a "first-person shooter" game. Half of the dyads and all of the triads played both of these games in competitive game play mode (against one another), and the remaining half of the dyads played both games in cooperative game play mode (in order to win the game participants had to work together). The 24 two-hour game play sessions were recorded using two video cameras one to capture the on-screen game play and the other to capture the facial expressions and gestures of the participants. This study (Hinn, 2005) was the most experimentally oriented of the three, actually taking place in a laboratory. However, substantial efforts were taken to create situations similar to game-playing scenarios that occur in people's living rooms.

Computer Supported Cooperative Work (CSCW): Informal Workplace Help-Giving

Several different workplaces were studied, including different departments of a large financial institution, a university library help desk and phone center, a university department, a design group of a large private manufacturing company, and an agricultural outreach unit. The approach used workplace observation and post-incident interviews. A few interactions were audio or videotaped. Informal help giving and collaborative problem-solving incidents were identified, coded and analyzed. Interviews asked about the episode from the perspective of the participants, the techniques used in resolving and explaining the problem, to what extent they 'solved' the problem, and whether it related to other episodes not directly observed (Twidale & Ruhleder, 2004). Other workplace studies have particularly focused on whom people ask. By contrast this study focused on what happened in the help-giving interaction itself, and the degree to which the software helped or hindered.

Computer Supported Collaborative Learning (CSCL): Children Around a Classroom Computer

A year-long study was conducted in a first-grade classroom in a public school. In this classroom, the students could use the classroom computers for work or games only during "choice time," between 2–3 p.m. from Monday to Thursday. During the fieldwork, the researcher visited the classroom an average of 2-3 times a week. Videos were shot of children in front of the two computers, Videotape, field notes, interviews and artifacts (including the students' computer work and log, the sign-up waiting list for the computer, and choice time log) were the main data sources. Interviews with all the students were used to gather the participants' views and perceptions of peers, computers and their interactions at the computer. Interviews with the teacher revealed her point of view of the class, peer culture and computer curriculum (Wang, 2003).

PATTERNS IN LEARNING HOW TO USE AN APPLICATION

Although the studies had looked at very different contexts of interaction with computers and applied somewhat different methodological and analytic approaches, the more we discussed our findings, the more we uncovered similarities, particularly in issues that relate to the process of learning to use an application. In all cases episodes occurred of collaborative learning of how to use a computer application. The extent to which it was computer *supported* collaborative learning needs more consideration, given that the applications were not explicit CSCL tools, but rather were ingeniously appropriated to temporarily support collaboration.

Appropriation for Use by More People than Designed

In all three studies, the number of people in some way using the computer is more than the applications were intended for. The applications may not have been considered to be CSCW or CSCL, but they were appropriated to be used as such. The resultant usage is a kind of Single Display Groupware (Stewart et al., 1999), a sub-field which considers interactions that occur when more than one person is using the same computer.

In the workplace studies, none of the typically used software (including regular office applications, databases, CAD systems, and web browsers) was explicitly collaborative. When a breakdown (Schön, 1983) occurred such as confusion about how to do something, the user may call on a colleague to help. Such situations are widespread and are widely reported in the literature (Twidale, 2005).

The console game study was lab based and so somewhat less authentic. Although have no data on how often more than two people are present when two player games are played in domestic environments, we do believe that it does happen, and that games designers might want to take it into account. Consequently, the study included both dyads and triads to enable the activity to be studied and compared to the 'proper' number of people. Many computer games include modes for individual play, for occasions when two players are not available.

The classroom only had two computers, and many children wanted to use the one computer that had the most popular games in the choice period. The teacher had created a set of rules to enable and enforce sharing of the

computer. There was a signup sheet with five minute slots and a timer, and two chairs in front of the computer. The teacher declared that that the child sitting on the left was the official player (with a legitimate turn) and the child on the right was the official observer. When the timer indicated the end of the five minute timeslot, the child on the left would get up and the child on the right then moved over to the left chair while the next-in-line child took the right chair. Any other watching or waiting was not allowed (Wang, 2003).

However these teacher-imposed rules of conduct were subsequently modified by the children. The five minute transfers happened very rapidly and smoothly, with the game continuing throughout. The children minimized the disruption of the turn-taking process, since the child on the right was already involved in the game and was ready to carry on immediately where the previous child left off. Also, the waiting child was often already part of the activity by (illicitly) watching and commenting from a standing position, and so ready to take on his or her role as the right-seated participant. This saved the considerable overhead in a 5 minute turn of quitting and starting a new game or even a new game application. Effectively only one game took place during the whole session, with the children involved in different ways and degrees throughout, and collectively attaining far higher levels of progress in the game than if each child started from scratch. Children who didn't get a turn would often approach the computer corner and stay watching and playing with the seated player. To justify this they used a wide range of strategies: signing up or checking the waiting list, ostensibly doing their chosen activities in the carpet area next to the computer, and observing from distance and finding a right time to join by offering suggestions. The number of these additional 'participants' varied from 2 to 8 with an average of 4. Thus a game that had presumably been developed for use by a single player on a single computer had been transformed into a paired collaborative activity as seen in many other educational settings (e.g. Inkpen et al., 1999) and further to a multi-player team effort with up to 10 children playing an ongoing game interwoven with doing other activities.

Additionally, and rather remarkably for this educational setting, the children mostly enforced the turn-taking themselves, as the first example below illustrates. The teacher was busy with the many other activities that were going on in free choice time. The children knew that they had somewhat modified the use protocols the teacher had created (by having more than two children engaged in the activity) and did not want to draw attention to that. Also, appeals to the teacher would use up their very limited time. This interesting situation of active rule enforcement by young children is explored in greater depth in (Wang, 2003). From the perspective of CSCL, note that in addition to any purported learning embodied in the application itself, the children were also independently learning important lessons about civics. These were not just about obeying the teacher's rules, but also about how to interpret them and deal with special circumstances not covered explicitly by those rules, such as what to do if someone's turn arrived but they had gone to the bathroom. Local policing and enforcement of the rules also had to be developed, for the reasons noted. There were frequent occasions where a child would be unwilling to relinquish their turn, or tried to cut in on the queue. The children resolved almost all these issues amongst themselves, by arguing from the rules, and by establishing alliances in exerting moral pressure (a child hogging the keyboard affected the access not just of the child whose turn it is, but the child who is next in line). It should be noted that in one sense this learning was not legitimate (see later). The teacher when asked was rather uncomfortable about its subversive nature: "I generally don't want students to enforce the rules."

Appropriation of Resources for Different Pedagogies

The following examples illustrate various kinds of help-giving learning or teaching techniques:

Sue: Where did you get the specifications from?
Can you show them to me?
Jared: [took over the mouse and keyboard and pulled out the information that Sue was asking for.]
Sue: Hey, how did you do that?"
I have never used that, what was it?
Jared: Oh this is just a function from here, you go to the menu, type in the option and you get this results, it's a very straight feature.
Sue: Cool, I will use it

Part of a larger interaction where Jared had asked Sue for help in solving a design problem with a CAD system. In the process of trying to understand the details of Jared's problem, Sue sees Jared obtaining the information she asked for in an unexpected way. She asks about it, and Jared repeats his actions more slowly so that Sue can follow them, describing them as well. Sue went back to her own workstation to look at some similar work that she was doing. She came up with a solution and walked back to Jared's desk, took over the mouse control and keyboard control again and pulled the files that she wanted on his computer herself and then made some changes to the figure and then she told him "This is how it should be".

CSCW: Mutual learning and teaching

Cooperatively playing "Halo" a first-person "shooter" style game. They need to figure how to make their characters duck under a door. They have already tried many other approaches including looking for solutions that avoid having to duck under the door.

Anne: [laughs] I'm thinking about tricks, you know? When I used to play Super Metroid…
Sara: [experimenting with different buttons] This is ridiculous though. We aren't even doing the point of the game.
Anne: Yeah but we are trying to figure out how to duck here. OK Sara, I'm gonna pause the game. [Changes mind and doesn't pause the game because Sara is still experimenting] OK, well you just keep doing it. I don't think there's a time limit. [Anne then picks up the game manual] [Reading out loud] A melee attack. Really. [Sarcastically] OK. Crouch. Left thumbstick button, press in. [Looks down at her controller] Oh! [puts down the manual]
Sara: What? [looks down at her controller and puts thumb over left thumbstick] This thing?
Anne: [Reaches over and presses down on Sara's left controller thumbstick] Push this thing. [She continues to press the left thumbstick on Sara's controller]
Sara: Whoa. Yeah! [Both successfully duck under the stuck door and move to the next game section]

Anne considers techniques from other applications that might help. They worry about time limits affecting their exploratory learning. Anne finally consults the manual, figures out what to do and shows Sara.

CSCP: Using analogy and consulting the manual

John: See where it says delete mail from server after so many days?
Fiona: Mm hmm.
John: I would recommend seven there.
Fiona: All right.
John: Just good practice."

John is not only showing Fiona how to modify some initial settings of a mail program, but also suggesting some useful values

CSCW: Showing how, what and why to act

Carrie: You need an umbrella, a big umbrella!
Ted: Yes! An umbrella.
Celia: How do I get an umbrella?
Carrie: Errr . . .
Celia: Carrie, you find the umbrella
pushing the mouse towards Carrie]
Carrie: [manipulates the mouse and finds the umbrella]
Now, you do it.
[pushing the mouse back to Celia]

Carrie is sitting and watching. She calls out strategic advice to Celia, who is operating the game. Celia doesn't know how to achieve the stated goal and asks. Carrie hesitates because she interprets the question as a request to take over and demonstrate. She is reluctant to go against the teacher's rules of who operates the computer and who observes. But when Celia more explicitly asks for her direct help she agrees, demonstrates the action, returning control to Celia, and challenging Celia to repeat the action herself.

CSCL: Request, demonstration, practice

[Kristen and Megan were playing, while Kevin and Nick were watching.]
Kevin: Why don't you go the hockey place?
[Timer goes off.]
[Megan moves to the left chair & Kristen gets up and leaves.]
Nick: [walking to the left to look at the waiting list]
Who's next?
Greg: [running to the list and writing down his own name] It is Ken.
Nick: [turning around] Ken! Ken!
Kevin: [turning back and pointing to the chair] Ken, come here. It is your turn.
[Ken was busy with another activity]
Greg: [grabbing the chair on the right, tries to sit down]
Nick/Kevin: No, Ken is coming.

Shortly after, Ken came to take his chair.

CSCL: Enforcing turn-taking

Tom: How did you do that?
Ken: [turning around] What?
Tom: Make the snow fall.
Greg: You just press some . . . the fast button, see . . . [demonstrating on the keyboard.]
Tom: The fast button?
<overlapping speech>
Jack: What is the fast button?
Greg: [turning back] The "Esc" button!

Underlined names are the children sitting at the computer 'officially' playing. Tom, watching the use of the application, is surprised by what he sees and asks for an explanation. He receives one, accompanied by a demonstration. The explanation uses a term he doesn't understand so he asks for a clarification and receives it. Jack is also watching and learning from observing the learning interaction between the others (an example of vicarious learning).

CSCL: Opportunistic Learning

We found many different learning approaches and pedagogies by which one person can learn how to use an application from another. These include: traditional instruction, demonstration with running commentary,

apprenticeship, creation and use of microworlds, practice sessions, legitimate peripheral participation, use of external representations, competition, scaffolding, handicapping, grandstanding, vicarious learning, help suggestions called out in real time, story-telling away from actual use, and post action reflection and discussion. This list neither purports to be complete nor original. The aim is to illustrate the sheer variety of methods that can occur in informal learning and teaching. The following subsections examine some techniques in more detail.

Demonstrating with Running Commentaries

In all three cases people used commentaries on the action being undertaken. The nature of the commentaries varies somewhat, but they appear to be an important part of the wider interaction process.

In the workplace study, demonstrations were very important (Eales & Welsh, 1995). They usually involved a sequence of actions performed and described interspersed with higher level commentaries such as particular values to use that had been found useful for the work being done, and reasons why these operations and values were used for this kind of work in this work group. For example, an explanation of how to attach a document to an email also covered the choice of which mailing lists to send it to, how to find details of those lists on the intranet, and the important distinctions of who was on which lists that would help in deciding which lists to select, bearing in mind subtleties of work relations and office politics. See also the third example above. Furthermore, nearly all the problems and solutions observed involved the use of more than one application in their resolution (such as extracting information from a web-based database, incorporating it in a document and sending it as an email to someone else). The running commentaries helped the participants to keep track of the mental workflows and various workarounds that they tried. Since the solution did not reside in any single application, no application-specific interface design, manual, online help, or tutorial no matter how good would have helped. In such circumstances it was clear why asking a colleague for help was so valuable.

In the school situation, the two children playing would discuss the game while others would watch and offer suggestions, or offer to help or to show the pair how to solve a particular challenge. Since the game was being played in real time, there were occasions when advice was time-critical, so unlike the workplace commentaries, this led to shouts of advice to avoid a problem or seize an opportunity. Sometimes children could not seem to resist helping or offering advice, either through a burning desire to help, to show off their knowledge, or to see greater progress in the unfolding game and the group achievement of a final high score. Thus some of the help offered was unwanted, distracting, and even ignored or rejected by the intended recipients.

In the console game situation, time-criticality also mattered. Help could be solicited or offered, accepted or rejected, but it had to be done fast. Different kinds of commentary could also occur. Some was more analogous to sports broadcasting – an analysis for the benefit of a wider (imaginary) audience, but clearly also interesting to the participants. Another kind is “trash talking”, when players would insult one another and/or their skills at the game. This was often accompanied with a harsher version of help giving. For example, one player might say “What an idiot – haven’t you figured out that it’s the ‘a’ button to shoot?”

Scaffolding

Many of the activities observed are different kinds of scaffolding (e.g., Quintana et al., 2002; Rogoff, 1990) that support the learning objective. Social scaffolding includes splitting up a task to make it easier to perform. This can range from simple division of labor to more conventional expert-novice work splits of strategy and tactics. Running commentaries can act as external memory, making the learner aware of issues that they need to act upon soon, and the consequences and meaning of the actions just taken. A partner may act as an emergency override, doing very little most of the time but ready to intervene if the user is about to do something dangerous, undesirable or difficult to recover from. The presence of such a social safety net can encourage more adventurous exploration than when investigating on one’s own, where recovering from unintended consequences of explorations can be so confusing or onerous that it inhibits learning by exploring.

In the case of workplace help, the running commentaries create a structure for the learner to make sense of the actions being done. Rather than being an arbitrary sequence of semi-magic steps, the explanations give the steps meaning and help in chunking them together into groups that help structure the activity. For example, help in how to create a web page may involve use of more than one application, and needs to cover issues of making sense of creating the HTML, testing the local copy of web page with a browser, uploading it to the server using a file transfer program, and then re-testing the now public web page. Without clarifications of the steps and their meaning, a learner may become confused by very similar looking actions that have completely different meaning depending on where they are done in the larger action sequence.

In game design there is a technique called “rubberbanding” where an AI computer opponent might be “forced back” by the program if it is too far ahead of the human player, as if being snapped back by a rubber band. In multiplayer games, an example of social versus programmed scaffolding is where a more expert player might pause in a race to allow their competitor(s) to get closer, to make the game more challenging.

Peripheral participation: legitimate and illegitimate

Lave and Wenger (1991) introduce the concept of legitimate peripheral participation (LPP) as a way of understanding learning. We have found it a useful analytic framework in all three situations, as skills are shared and relative novices are helped to learn how to use the applications more effectively. However we also saw cases

of contested legitimacy – learning activity that looks more like what might be called illegitimate peripheral participation. Note that Lave and Wenger take pains to emphasize that the components of LPP should not be considered in isolation, or in contrast to their antonyms. They would regard all learning as legitimate in the sense of meaningful for the learner. However we use the term 'illegitimate' to emphasize that some learning may be unsanctioned or subversive. For example in the classroom, the teacher believed that just passively watching others playing was a waste of time, and so had established a rule of "no watching". Children were meant to do another activity while they were waiting for their turn on the computer and move on to another activity after their timeslot ended. In practice, as noted, children lurked around the computer, but carefully trying to stand so that they were not perceived by others, particularly the teacher as too close. Occasionally one child would accuse another of 'watching', and this would be resolved in various ways, either by the watcher leaving, moving a little further way but still watching, putting their hands over their faces to imply that they weren't really watching (while peeking through their fingers), or most ingeniously of all, claiming to be 'observing', not 'watching'. Observing was an approved action in that classroom, associated with science activities. Bruckman (1997) notes an analogous episode in her study of the use of MOOs in education: "when a student at Massachusetts Public stood for a few minutes watching over one of her classmate's shoulders, she was admonished not to waste her computer time, and ushered over to an empty workstation."

INTERLEAVING WORK, LEARNING & PLAY

Our three contexts of play, school, and work just happen to match the sequence of three leading activities in modern industrial society - identified by Leont'ev (1981). These are typically viewed as distinct, but we were led to wonder about their actual or potential merging. In all three studies we saw cases of learning embedded in other activities. In the workplace, a problem causes a shift from doing the work to learning and problem-solving. In playing a game, players want to improve, which implies learning, and skill disparities may necessitate additional learning in order for all players to have an enjoyable time in a challenging competition. In interacting with peers and waiting one's turn to play a game in a classroom, children seem compelled to help each other improve. Work and learning clearly interleave, as do learning and play, and neither pairing is too surprising. But reflecting on each others studies leads us to wonder about the importance of play in learning in contexts outside the educational one. Although at first glance a rather strange idea, others have explored it including Gaver (2001): "There is a danger that as technology moves from the office into our homes, it will bring along with it workplace values such as efficiency and productivity at the expense of other possibilities. People do not just pursue tasks and solve problems, they also explore, wonder, love, worship, and waste time." We agree with Gaver's position, which explicitly draws on Huizinga (1953), that the design of technologies intended for non-work contexts needs to consider non-work human behaviors like play, and by implication also facilitate playful and at times collaborative learning of how to use home-based applications. However we would go further. The interleaving of the pairs of work & learning and play & learning led us to wonder about three-way interleaving. Do games have a component of work in them? Does the playing of games have implications for work? Do all contexts have some combination of work, learning, and play co-present in different ways and proportions?

Short but precise definitions of 'learning', 'work', and especially 'play' are notoriously difficult to create, as illustrated by Wittgenstein's (1953) exploration of the related problem of creating a precise definition of a 'game'. However we do think that there are attributes (or as Wittgenstein puts it, "family resemblances") of these kinds of activities that can or should be explored in different contexts. Learning is the least problematic of the three. It can take place in specially designated places (schools, universities, corporate training suites) or as a part of other activities (doing paid work, playing games, in the home, etc.). The idea of learning has attributes including reflecting, transforming, improving, practice, diagnosing, redesigning, and improving. The idea of work has attributes such as constructing, seriousness, effort, value, goal directedness, and worth. The idea of play has attributes such as joy, creativity, unreality, escape, wastefulness, lack of constraint, and exuberance. Even such a listing of attributes is controversial. However we have done so in order to begin to explore whether some of these attributes may appear in different ways and in different proportions in all contexts. This exploration of the attributes of learning, work and play helps show why people might feel uncomfortable with certain blending and why they sometimes try to keep play out of formal situations of learning, particularly in educational and training contexts, as well as out of work (Prensky, 2001).

Does workplace learning have a playful component in it, or if not, should it? Learning a feature in MS Word does not appear to be as much fun as figuring out how to get to Championship Level in Tennis 2K2. However, the informal workplace help-giving interactions observed often had some aspects of playfulness about them. Sometimes it was a break from routine work, or a chance to interact with a colleague as a change from solitary work. Sometimes social interactions (greeting people as they arrived or passed by) turned into a request for help. Nardi notes that even mundane work related applications such as spreadsheets led to the emergence of local developers who chose to spend more time 'tinkering' (a term implying playfulness); learning about the technology and interacting with programmers (Nardi, 1993). There is a growing body of research on issues of play or fun and its relation to computer use (e.g. Blythe et al., 2003; Pagulayan et al., 2003)]. Some of this work looks at informal use of computers either as games or as part of everyday non-work life. Others explicitly

address the question of whether we can or should draw on computer games as inspiration for workplace tools, particularly to support the learning of those tools (e.g. Carroll, 1982; Draper, 1999; Malone, 1981; Neal, 1990).

Play is an important part of all human's behavior, serving a therapeutic role. The etymology of the word 'recreation' points to that. However we think that there is more to be said than encouraging workers to take periodic breaks maybe involving a short computer game. Rather we wonder whether some of the attributes we often ascribe to play are important in learning, and should be more explicitly validated and supported, equally in the workplace as in other environments such as domestic or leisure pursuits. Much is said about the importance of play in the learning of young children (e.g. Vygotsky, 1967), even noting how it can sere an emancipatory role in play forms that actively and expressly challenge the propriety of adult customs (Leont'ev, 1981; Duncan & Tarulli 2003), exactly as was found in the classroom study. Is there also a role for different kinds of playful activity in the learning of older children and adults? (Resnick, 1998; Landry, 2000; Prensky, 2001) We think that there are certain aspects of play that may be important in learning: apparent wastefulness, apparent unreality, and opportunities for creativity.

The Apparent Wastefulness of Play

Play is intrinsically motivating (Leont'ev, 1981). It usually involves doing something just for the fun of doing it, rather than to achieve a greater goal. It can be contrasted with work, which is usually done for its results, not just to be in the state of doing it. Play seems 'wasteful' compared to work. Similarly, learning often involves short term 'wastefulness', but in pursuit of a longer term performance gain. Even if the learning is tightly integrated with performance (as in apprenticeship and coaching), activities such as reflection, explanation, discussion, and practice of subtasks still entail a short-term performance loss. Learning seems to need some slack (interestingly, another meaning of the word 'play') in the system. With no slack, you just do the work; there is no time to consider how it might be done better in the future. We believe that an application can best support collaborative learnability (Eales & Welsh, 1995) by providing features that allow for the use of a range of different pedagogies. These too will impose a performance overhead (both for the developers and the users of the application), and so are wasteful from the strict perspective of immediate operational efficiency. Nevertheless they are justifiable in terms of incremental productivity improvement via learning. This consideration of waste and learning has parallels with the work of Dewey, who had rather mixed views about play. For Dewey, waste in education occurs when the focus is on some hypothetical end far beyond the school (Dewey, 1907). It is then that we waste the precious resource of the child's experience. Conversely, work is actually wasteful when it removes the joy of life. He argues (Dewey, 1927) that the real productivity for society comes when work, too, promotes the full development of the individual, which requires both learning and play, embodying reflective action.

The Apparent Unreality of Play

Dix (2003) notes how young animal play can be regarded as a learning process, allowing the animal to practice its responses to potential life experiences such as hunting. Play allows learning through vicarious experience, but only if coupled with imagination so that the play experience in some way stands for something other than what it is – a kind of safe mental microworld. Unlike work, the activities taking place during play can be regarded in some sense as 'not real' in that they often do not have the same consequences as related activities in real life. Play isn't real, but it is like reality. Play might allow you to practice situations ready for encountering in real life, and try out new things in safety mode. Play is like many of the things we do in formalized workplace learning, including using models, scenarios simulations, scaffolding and practice (Schrage, 1999).

Opportunities for Creativity Through Play

There are two kinds of playful use; play *within* the application, exploring and learning its features and play *with* the application, using it in creative ways to achieve unexpected results. An aspect of the former can be found in Carroll's (1998) Minimal Manual approach to supporting workplace learning. This advocates encouraging and supporting exploration and innovation right from the start of learning a new application. It also has an emphasis on creating safe tasks and sequencing tasks safely, essential if playful behavior is to be encouraged. Dix (2003) notes the importance of play for engendering imaginative creativity that can be channeled into novel design ideas, particularly when childlike playfulness interacts with adult rationality. Such design ideas are likely to be very different from the incremental improvements of purely rationalist work-like analyses of a problem. It seems that certain actual and mental constraints are released in play enabling the asking of surprising questions about use. The importance of play for creativity has a long history (Schiller, 1955). Fischer has explored how creative insights are often initiated by breakdowns (Fischer, 2000; Schön, 1983) and has explored how to support both individual and social creativity. Similarly we found how breakdowns can lead to various different kinds of learning and teaching. We see playful interactions with many communications technologies leading to new styles of interaction, as for example with young people's use of text messaging, instant messaging and blogging (e.g. Grinter & Palen, 2002; Grinter & Eldridge, 2003). Some of these innovations are then adapted for other contexts, including work. Indeed teen socializing may not even be considered a form of 'play', but nevertheless the appropriation and development of the medium derived from playful interactions to discover new ways of using it.

INFORMING FUTURE WORK

Each of the three authors has been forced to re-examine their own studies and the implications they have for future research and design in the light of the findings of the other two studies. Here we consider some of the issues that arose from our conversations - although not immediately derived from the few particular examples that limited space forced us to select in this paper.

Designing for Appropriation of Use by More People than Intended

Thinking about designing to enable the collaborative learning of how to use an application should not just be a concern for the educational computing world. Rather, CSCL researchers have much to say to the developers of CSCW applications and even purportedly single-use applications about supporting collaborative learnability of application use. During breakdown a single-user application becomes briefly a CSCL application, raising the question of whether or how to explicitly support this brief ad hoc CSCL role. How should we introduce these ideas into design discussions where the concept of CSCL is alien? This is analogous to the struggles of many HCI researchers and practitioners to make the case that usability issues should pervade the software development process. It creates the need for lightweight techniques and guidelines as well as systematic development of exemplar functionalities and interfaces to explicitly afford temporary ad hoc multi-user interactions. Even within educational computing, a consideration of learning to use an application can be swamped by the far more prominent concern of using the application to learn something else. Inspired by the school and game cases we can explore the idea of extending a single user workplace interaction not just to a learning/helping dyad but to larger groups of people watching and participating. When would such kinds of public learning and group problem solving (say grandstanding round a cubicle) be appropriate? Are they ever efficient? How could software facilitate them? Is vicarious workplace learning useful and efficient, and how might it be supported? Does it suffer the same timewasting legitimacy issues as in the school, and are these concerns valid?

Designing for Spontaneous Appropriation of Resources for Different Pedagogies

There is no one right way to learn a particular application. Traditionally in CSCL we think of systems designers interacting with educators to select and create particular learning experiences using particular pedagogies explicitly designed into our software. However all three of our contexts reminded us that this is not the only way to do CSCL. It can be spontaneous and ad hoc, undertaken by the participants themselves, using or appropriating application features and interfaces to achieve the results they want using the pedagogies that they choose, without the benefit of higher degrees in education, psychology or computer science. The results may not be optimal, but there will be many situations when they are better than the available alternatives. It is provocative to us to consider how we might design to support these kinds of unplanned ‘amateur’ CSCL learning experiences and whether the need different support than the very carefully designed experiences more usually reported in the CSCL literature Different people will try different pedagogic techniques depending on the overall context and what seems to work. Indeed in one sense the application developer need do nothing. People appropriate application use to enable the learning of those applications by others, even when they are not themselves education researchers. But it is worth considering how we as designers might help that process (Dourish, 2003). We already have many checklists, heuristics and methods to inform design for usability and individual learnability (e.g. Nielsen, 1993). Can we work towards something similar for collaborative learnability? A low-effort starting point might be running through a list of pedagogic techniques and considering how to help people employ those techniques to support the learning of the application.

We believe that the issues identified have a number of implications for systems and interface design. In the case of games, features could be provided to support grandstanding and running commentaries, drawing on the kinds of actions done by TV sports reporters’ use of action replays, selections of significant clips, annotations, use of statistics etc. More advanced features could involve completely separate interfaces (and most likely separate displays) for the players’ and the commentators’ creation of public displays and representations. Thus the players may focus in on the game interface while the commentator takes that feed and manipulates it as a TV sportscaster takes in and manipulates multiple camera feeds of a live sports broadcast. Asynchronous possibilities include the creation of edited highlights and compilations to show to others (including the original players), and to share these with others not present when the game was actually played. There are already examples of communities doing just this kind of activity. For example players of Quake create run-throughs of levels to illustrate their prowess (see www.planetquake.com/qdq/). Such run-throughs can also be used to illustrate gameplay or strategies to other members of their gaming community. Following our comparative theme we can ask when similar commentary and grandstanding activities might be appropriate in formal education and the workplace. Similarly the time-critical shouted out advice seen in games makes us wonder about learning about time-critical usage issues in the workplace.

Many games, especially sports games, have a single-player practice mode. However we are not aware of games that make it easy for two people to set up a training mode where a more expert player can show a novice

player some critical skills without a game play penalty (i.e., showing the other player a skill that puts the game at risk for one or both players). An example of this might be a training room where players of a fighting game could spar against one another with no time restrictions or move that ends the game (unless of course the players choose to end the training themselves). Another example might be a skate park where players can teach one another basic boarding moves while not competing for trick points and/or racing each other. Formal handicapping is an effective way for players of different skills to compete in an enjoyable manner in games as disparate as go and golf, and so likely to be just as useful in computer games as an extension of the informal kinds we observed.

For workplace help-giving, we are investigating supplementary interfaces for supporting discussion of a help-giving interaction (Twidale & Ruhleder, 2004). Most help-seekers attempted a solution themselves before resorting to asking for help. However describing exactly what has been tried can be difficult, especially for non-expert computer users who lack specialist terminology. Mechanisms for recording and representing the process of a sequence of actions can support discussions of what has been tried so far, what might be tried next, and when a solution has been found, creating a record of what to do for future use (Favorin & Kuutti, 1996). Explorations of complex solutions occur when the help-giver is unsure of the solution, and wishes to experiment (or play) safely. This can be done by a skilled computer user, but greater support for experimental, exploratory, playful use, as compared with efficient use for regular tasks would help many users. The distinction parallels that between 'practice mode' and 'compete mode' in games. For CSCW applications in particular, practice modes may involve social scaffolding and may need the easy creation of multiple dummy logins for participants who are not taking on their official roles. It can help if some of those can be simulated, so that a practice session with 8-way communication can be achieved by just 2 or 3 participants.

In schools, a greater sensitivity to shared use is already impacting application design, such as options for splitting activity smoothly between keyboard and mouse, or between two sides of the keyboard (Inkpen et al., 1995). Other options might be to create scenarios for an extra person to take on a monitoring role to issue suggestions to the players actually directly interacting with the keyboard. Perhaps the most important implication is less for application design than for curriculum design. We wish to emphasize to teachers the different kinds of learning and social interaction that do already occur around such games (or other applications) in various situations, and to encourage consideration of wider lessons such as helping, turn-taking and the organization of group behavior. These are important skills for children to be learning and the organization of fair play around the game is worth considering as a 'teachable moment' rather than as an annoying, potentially disruptive and educationally lightweight play option.

The issue of legitimate or sanctioned learning that was discovered in the classroom forces us to consider whether it might play a role in other settings. Where else are certain kinds of learning contested? Are there cases where informal help is considered a threat to approved information sharing channels, a waste of time or inappropriate? Can unsolicited help be a problem? Similarly, the cutting and pasting of resources between several applications in the workplace in order to achieve a complex workflow task challenges the very idea of what counts as application design or end-user tailoring. How might we design to enable children or teens to playfully and creatively combine different programs to do a complex task or to invent a meta-game using a composition of several games or games with non-game software?

Designing for Interleaving Work, Learning and Play

How might we help encourage playful learning and creativity? The decision to play with an application, or to interact with it in a more playful manner than normal is to a large extent external to the application, being a matter for the individual(s) involved and their particular context. The application cannot and should not enforce playful use and maybe can't even successfully encourage it. The attempt can easily backfire, as the widespread negative reactions to Microsoft Word's 'Clippy' show. But can an application's design afford playful use, or at least not inhibit it? To support exploratory play, there needs to be relatively low effort cost, low consequences of failure or of undesirable effects, and clarity of actual or anticipated consequences. In other words it needs to be safe for the user(s) to ask questions like "I wonder what will happen if I do this?" and "Shall we try doing this for a short while just to see what happens?".

In work situations there may be a training infrastructure, but it is expensive and usually best suited to larger scale learning interactions (such as classes, seminars and courses lasting an hour or longer), or ticket-driven technical support for complex problems, rather than the lightweight ad hoc informal interactions lasting seconds that can particularly aid incremental learning. Thus there is still a need in the workplace to legitimate and encourage informal learning and help-giving. In many non-work situations, there will be no extensive training infrastructure. For example, applications for domestic use are more likely to need to rely on both individual learning and informal help-giving between family members and friends. Explicit support for this could be crucial to adoption in enabling users to overcome the learning barriers to powerful but complex functionalities.

Other Contexts for Learning

Fortunately in some contexts, the very act of learning and help giving can become part of the point of the interaction rather than a desirable but nevertheless overhead on the main activity of using the application. For example, many researchers are investigating the use of collaborative applications to support the sharing of digital photographs (e.g. Frohlich et al., 2002). As those researchers note, this is not just about the access and transferring of files that happen to be images. Rather it is about providing technologies that families can use and indeed appropriate to share experiences, and memories, to precipitate story-telling, and so to interact with each other. Given such a situation, a scenario of a grandchild showing a grandparent how to use the application to create a special album or display is not an example of a learning overhead, but part of the very point of the application. Consequently the design to support such kinds of help-giving deserves just as much attention as the design to support the purported use of the application.

CONCLUSION

From three separate studies in three very different use contexts we have come to a deeper realization of the ways in which people use an application to support the learning of that application by others – creating spontaneous or ad hoc CSCL. This led to an exploration of how to design to support the varied pedagogies that may be used in such collaborative learning of applications. The role that play and playful behaviors can play in the learning of applications and in the development of creative solutions was also explored, leading to a consideration of how to design to support playful use.

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