SCAFFOLDING DIFFERENT LEARNING ACTIVITIES
WITH MOBILE TOOLS IN THREE EVERYDAY
CONTEXTS

Abstract. The aim of the study is to apply the theoretical framework of collaborative learning and
distributed cognition for developing mobile tools which scaffolds people’s everyday learning and
information searching and processing needs. This study includes experimental case studies conducted in
natural settings with randomly sampled or conveniently selected subjects. Contexts of the case studies
varies from the urban pedestrian street to the main library of the university. Both qualitative and
quantitative methods and multiple data collection techniques are used to get information how these tools
could be used for scaffolding everyday activities in different contexts. Multiple contexts give more
accurate picture how mobile devices can be used as cognitive tools to scaffold activities from
collaboration to topical information delivery. Preliminary results shows that subjects used mobile devices
versatilley as cognitive tools, but not always in that manner that researchers expected.

1. INTRODUCTION

One of the most significant mechanism today through which learning is transformed
is technology. Over the history, a range of artifacts have been produced which
modify the way how people learn in various situated practises (e.g. Invention of the
chart). Especially representational tools, such as calculators and mindmaps, have
changed our daily practises in many spheres of life quite dramatically (Saljö, 2003).
The new technologies provide opportunities for creating learning environments that
extend the possibilities of old technologies (books, blackboards, television, radio)
and offer new possibilities for multiple social interaction (Bransford, Brown, &
Cocking, 1999). Over a twenty years ago Alan Kay (see Barnes, 2001) dreamed of
what he called Dynabook. Kay planned Dynabook to include such features as flat
panel display and wireless communications. Nowadays ideas of Dynabook have
been realised as mobile technology that has become integrated in daily activities,
especially in mobile phones which have been widely used in many countries. For
example, in the Nordic countries one can say that mobile telephony is approaching
ubiquity (Mifsud, 2003). Mobile telephones, personal digital assistants and laptops
can be generally named as daily handheld devices.

Handhelds have emerged as one of the recent technologies for supporting learning;
that is because they offer new opportunities for individuals to learn anytime,
anywhere. Handhelds enable people to access Internet resources and run
experiments in the field, capture, store and manage everyday events as images and
sounds, and communicate and share the material with colleagues and experts
throughout the world (Sharples, 2002).
Handheld computers will become a compelling choice of technology for learning because they will enable a transition from occasional, supplemental use to a frequent, integral use (Soloway et al., 2001). The early evaluations have suggested that there are positive effects on learning with handhelds (Crawford & Vahey, 2003; Lundby, Smordal, Larsen, & Fjuk, 2002) and recently this phenomena, called mobile learning, has received increased interest among the researchers. The simplest way to define mobile learning is “learning through mobile devices” (Quinn, 2000). It has been questioned if mobile learning is only a commercial trick or passing fad (Karran, McManus, & Pohjonen, 2003) and the most important question is whether mobile learning has a sufficient pedagogical definition (Järvelä, 2002).

2. THEORETICAL FRAMEWORK

One of the advantages of using technology is its capacity to create new opportunities to bring real world problems into the classroom for students to explore and solve. It is said that interactive technology can help to create an active environment in which students not only solve problems, but also find their own problems (Goldman, Zech, Biswas, & Noser, 1999). The authenticity of the learning situations and tasks is assumed to be an important factor that can facilitate higher order learning (Brown, Collins, & Duguid, 1989).

In this study technology is used to scaffold learning in authentic real world contexts. Wireless cognitive tools can bring new methods to promote learning in Computer Supported Collaborative Learning. In this context scaffolding can be discussed in terms of the scaffolding process of collaboration, cognitive scaffolding and motivational scaffolding. In cognitive scaffolding of CSCL, we consider the cognitive mechanism of social and individual aspects of knowledge building (Anderson, Greeno, Reder, & Simon, 2000; Scardamalia & Bereiter, 1996). In motivational scaffolding of CSCL, students should be helped to see the value of the learning task from their personal point of view and, for instance, of its potential application outside of the school context (Brophy, 1999). In this study different cognitive tools are utilized to scaffold informal and formal learning situations in different field studies.

2.1. Collaboration and Knowledge building

Collaborative learning and knowledge building is seen as one of the most meaningful ways to support individual learning mechanisms with the help of the social and interactive learning (Bereiter & Scardamalia, 1989; Dillenbourg, 1999). Collaboration necessitates that participants are engaged in a co-ordinated effort to solve a problem or perform a task together. This coordinated, synchronous or asynchronous activity is the result of a continued attempt to construct and maintain a shared conception of a problem (Roschelle & Teasley, 1995).
The benefits of the technology for collaboration and knowledge building comes from the advantage of effective thinking tools available (Bereiter & Scardmalia, 1989) and shared knowledge resource as computer database available. For example, knowledge building environment, such as CSILE can be an environment for building, articulating, exploring, and structuring knowledge. The collaborating partners can use the environment for writing notes, creating charts, and reading and commenting on each other's productions in a communal database. In order to foster active production of knowledge, students or collaborating partners themselves are responsible for producing all knowledge in the database. (Hakkarainen, Lipponen, & Järvelä, 2002)

Nature of the learning task is one crucial determinant of successful collaboration (Arvaja, Häkkinen, Eteläpelto, & Rasku-Puttonen, 2000). If learning tasks are too obvious and simple there is no space for questions, negotiations and arguments. Another big challenge of CSCL is to provide real group tasks and contexts that stimulate questioning, explaining and other forms of knowledge articulation and demanding collaborative activities. (Järvelä, Häkkinen, Arvaja, & Leinonen, 2003) Roschelle & Pea (2002) are critical towards traditional CSCL environments that are bound with the constraints of the computer lab or specially implemented computers in the classroom. Wireless technology and ubiquitous computing could provide possibilities to found stimulating contexts and tasks and create new kind of learning tasks. Mobile technologies not only help children to collaborate in a more active way within real physical world, as well as as the physical world being augmented trough digital technology, but also provide opportunities to design for multiple kinds of collaborations to support learning (Price, Rogers, Stanton, & Smith, 2003).

Location-aware computing is currently emerging and it will have impacts to CSCL research area. Ubiquitous and pervasive computing and geoinformation will create new possibilities to implement collaborative learning environments. It will be possible to point a mobile device at an object (e.g. Building, tree, bust stop) or peer people and obtain information or start to collaborate (floating discussion thread) (National Research Council, 2003). First educational implementations of the location-aware computing have been conducted on museum or enviromental learning settings (Okada, Yamada, Tarumi, Yoshida, & Moriya, 2003; Proctor, 2003).

2.2. Distributed cognition

People’s actions are intertwined with the artifacts of their work; their team member’s roles, responsibilities, and actions; and even their cultural and historical setting(Olson & Olson, 2003). Different artefacts are constantly used for structuring activity, for saving mental work, or for avoiding error, and they are adapted creatively almost without notice. (Pea, 1993)
Our intelligent behaviour is result from the distributed cognition (or distributed intelligence (Pea, 1993)) - where are both social and material dimensions. The social dimension of distributing cognition comes from its construction in activities or trough people’s collaborative efforts to achieve shared aims. The material dimension originates in the situated invention of uses for aspects of the environment or the exploitation of the affordances of designed artefacts. (Pea, 1993; Pea, 1993; diSessa, 2001; Norman, 1993). DiSessa reminds that material intelligence does not reside in either the mind or the materials alone – nonreader cannot read book, she or he doesn't even know how to use book. According to diSessa (2001) social and material dimensions stands only in conjunction with what we think and do with our minds. Third dimension behind our intelligent behaviour is mental or cognitive that couples external and internal activities.

Norman (1993) suggests that information in the world could be thought of as kind of storehouse of data. The physical structures available in the world will help us to remember things and make selections. On the other hand, our living environment offers many examples of “smart tools” that we are using to mediate activities and augment our thinking e.g. measure or calculate (Pea, 1993; Norman, 1993). Thousands of software tools are used daily by mathematicians, medical researchers, physicists and so on collect, sort, analyze and present data. There are even metatools that are used to build other tools, for example programming languages and game editors (diSessa, 2001).

2.3. Technology as a cognitive tool for individual and social learning

The most pervasive and the most self-explanatory cognitive tool is language which distinguishes humans from animals. Language amplifies the thinking of the learner and gives possibilities to express and share ideas and beliefs. Throughout our history, different mechanical tools are developed to amplify and facilitate physical work. Those tools provided humans enormous mechanical advantage. (Bereiter & Scardamalia, 1993; Jonassen, 2000). Besides mechanical tools humans have developed and implemented different cognitive tools throughout our civilized history. In the broadest view cognitive tools may be provided by any medium and those tools help learners transcend limitations of their minds and share the cognitive burden of carrying out the tasks (e.g. memory, thinking, problem solving). (Pea, 1985; Salomon, 1993)

The information revolution has extended that advantage by extending functionality and speed of tools and giving new possibilities to develop and implement those tools. Its argued that cognitive tools not merely amplify but reorganize how learners think (Pea, 1985). (Jonassen, 2000) uses term mindtools instead of cognitive tools. Mindtools are cognitive tools of the knowledge society - software applications (e.g databases, spreadsheets, semantic network programs, expert systems, system modelling tools, microworlds, hypermedia authoring) that have been adapted or developed to fuction as intellectual partners with the learner in order to engage and
facilitate critical thinking and high-order learning. When learners are using mindtools to represent what they know it necessarily engages them in variety of critical, creative and complex thinking. (Jonassen & Carr, 2000)

Until today mobile devices have been used almost merely for communication. According to (Reeves & Laffey, 1999) the utilization of technology in teaching can be seen as a dimension which starts from information delivery and ends with cognitive tools. Just as Reeves states, newest mobile devices (e.g. smartphones, pda's) have become versatile cognitive tools which have rich educational possibilities. Roschelle & Teasley (1995) have envisioned the revolution of the Wireless Internet Learning Devices (WILD). According to them, pervasive WILD classrooms should support computational media with cognitively empowering representations and network communication both among local peers and to distant servers just like traditional computer labs. Roschelle & Pea (2002) highlights that there may arise more differentiated places for information and knowledge, and highly differentiated devices with different characteristics may proliferate and special purpose information appliances may emerge.

3. AIMS

(1) To apply the theoretical framework of collaborative learning and distributed cognition to develop such technological tools which scaffold people’s everyday learning and information searching and processing needs.

(2) To evaluate in experimental case studies how the tools can be used for scaffolding everyday activities in different contexts.

Figure 1. Research Design
This study includes three experimental case studies conducted in natural settings with randomly sampled or conveniently selected subjects. Case studies are particularly well suited for mobile human computer interaction research focusing on describing and explaining different phenomena and producing rich data from those (Kjeldskov & Graham, 2003).

Concurrent, triangulating mixed method approach has been used to collect rich research data (Tashakkori & Teddlie, 1998). Both qualitative and quantitative methods has been used in attempt to confirm, cross-validate and corroborate findings within different cases. Although data collection has been concurrent, priority between two methods was given to qualitative approach because multiple qualitative data collection techniques are used. Used data collection techniques varied in different cases, but semi-structured discussions are always used. (Creswell, 2003)

Qualitative data collection methods were different observations, questionnaires with structured questions and semi-structured discussions. Quantitative data collection techniques were questionnaires, logged information and statistics from discussion databases of FLE3mobile.

5. CASE STUDIES

5.1. CASE 1: FLE3mobile – Scaffolding collaborative knowledge building in geographically distributed team

The special mobile knowledge building tool, FLE3mobile was used in an experimental case study in the northern Finland in June 2002 (Laru & Järvelä, 2003). The subject of the study were 10 distance learning specialists of which 4 worked as managers, 1 as teacher, 1 as designer, 1 as computer helpdesk / support and 3 as production assistants. 5 subjects worked in the university while the other 5 worked in the learning centre in rural area. Distance between working places was over 200km. All subjects had a joint goal for collaboration and an authentic need to plan and coordinate a virtual Master’s Programme in Information Sciences.

Due to distance subjects were used to take phone calls, arrange videomeetings and send emails to arrange their everyday activities when there wasn’t acute need for the face-to-face contact. Even though subjects had used different tools to scaffold activities before experimental study they weren’t fully satisfied to the situation (Goman & Laru, 2003). There was a clear need for a tool which would enhance communication and collaboration between subjects. Answer for this need was experimental FLE3mobile tool which was used to scaffold coordination of collaboration of the subjects in a specific period of their work. Used tool was based on Future Learning Environment (http://fle3.uiah.fi) and made to be compatible with
restrictions of the PocketIE (www-browser of the PocketPC handhelds) by modifying the original user interface. (Laru & Järvelä, 2003)

5.2. CASE 2: TiernaJack - Scaffolding people’s situated information needs at the downtown context

This case study describes TiernaJack, a free-cost information service which was meant to give both additional and topical information about Tierna-time activities at the downtown area of the Oulu during Christmas 2004. TiernaJack service was one of the first implementations of the Sonera’s iJack™ service all over the world.

iJacks were located at the local restaurant and in the corridor leading to the local Fashion store, so all citizens were able to use the service without any costs with their own or loaned devices. TiernaJack was advertised with two A1-sized posters located in proximity to short-range wireless connectivity provided by the iJacks. Interested people were able to download special content to their own mobile phones; pictures, an animation, tierna-history and a schedule containing information of the events of the Tierna-time. (Havana, Laru, Vanninen, & Väinämö, 2004)

5.3 CASE 3: SmartLibrary II – Scaffolding library patrons to find books and other resources with location-aware mobile tool

SmartLibrary service was developed to help users to find books and other material from library. The help is provided in form of map-based guidance to the target bookshelf on a PDA and is integrated to the online catalog of library, so that books retrieved from the catalog can be located. (Aittola, Ryhänen, & Ojala, 2003)

Next generation version of the SmartLibrary service with enhanced features will be launched at spring 2004. When new version of the smartlibrary is available, extensive and multidisciplinary user evaluation with real users will be conducted. First results from collected user evaluation data of the new version of the SmartLibrary service will be available at early summer 2004.

6. RESULTS AND CONCLUSIONS

The first case study showed that it’s not possible to change daily routines and work culture by one experiment. Collaboration between workgroups was formal and hierarchic, so knowledge building tool implemented wasn’t best possible solution to support interaction between them. Total amount of the messages exchanged between the participants was only 20; although the subjects didn’t use handhelds for building knowledge they versatility used devices as cognitive tools. For example, many of the subjects used handhelds to write down personal notes. In general, the subjects were eager to test the handhelds, and wanted to investigate how those devices could be useful in their work. (Laru & Järvelä, 2003)
Preliminary results of the second study show that subjects had a positive attitude to a tested TiernaJack service. Despite of the fact that TiernaJack had some usability and technological problems, subjects had feeling that tested service is useful and meaningful for their information needs when they are spending time at downtown context. Because it was possible to download the topical content from iJack service to appropriate mobile phones, almost all subjects told that it would be a good substitute for a newspaper in the future. Interestingly the subjects valued more clear textual information than pictures or animations that was offered within the content. General attitude was that service can be a useful way to get information at downtown contexts, but the offered content has to be meaningful and important to person itself.

Third case study hasn’t started yet. User evaluations will start when the second generation version of the SmartLibrary software is ready for implementation. User evaluation of the first generation software in the main library of University of Oulu showed that SmartLibrary helps the library users to find books easier in comparison to conventional shelf classification (Aittola, Ryhänen, & Ojala, 2003). Main interest in conducted user evaluation was to compare between traditional and tested self-location methods. There wasn’t qualitative research interest to produce clear picture how used tool would scaffold library patrons. In third case study multiple data collection methods will be used to get rich research data about how location-aware library service scaffolds learning and information searching activities. First results from collected user evaluation data of the second generation version of the SmartLibrary service will be available at early summer 2004.

In this study three different empirical cases have shown how mobile tools can be used to scaffold user learning and information search activities in the different contexts. Multiple contexts give more accurate picture how mobile devices can be used as cognitive tools to scaffold activities from collaboration to topical information delivery. In order to progress in this research theory-based pedagogical ideas for implementation of mobile tools as well multidisciplinary collaboration for the realistic design of the future mobile applications is needed.

**AFFILIATIONS**

*Mr. Jari Laru*, Department of Educational Sciences and Teacher Education, P.O.BOX 2000, FIN-90014 University of Oulu, Finland. Telephone: +358 8 553 3653, Telefax: +358 8 553 3744, Email: jari.laru@oulu.fi

*Prof. Sanna Järvelä*, Department of Educational Sciences and Teacher Education, P.O.BOX 2000, FIN-90014 University of Oulu, Finland. Telephone: +358 8 553 3657, Telefax +358 8 553 3744, Email: sanna.jarvela@oulu.fi

*Corresponding author*
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J. LARU & S. JÄRVELÄ


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