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Designing Collaborative Authoring Tools for Mobile Learning

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1. Introduction

According to the constructionist pedagogical paradigm, learners should play an active role in their learning process as they build their own knowledge. Learning can be viewed as a state change that results from past experiences and from interaction with others. It is strongly based on the "learning by making" idea, so learners should continuously create things to express their vision. Collaboration is also pointed as a key component of this learning process, one can learn from the interaction with teachers or with peers.

Collaboration is not only important for Education, it improves people's productivity. Many applications focused on collaborative working have appeared in the past few years. This phenomenon is very common in Web 2.0. People can use web-based applications to collaboratively write documents, manage projects, share files, and so on. Some of these applications allow people to work simultaneously on distinct computers. This kind of empowerment of collaborative working can be only achieved with technology mediated situations.

Moreover, mobile technologies such as laptops, PDA and mobile phones enable teachers and learners to create different learning settings, which are not restricted neither to classrooms nor to desks. The physical mobility provided by these devices created a new study area called Mobile Learning. It focuses on learning across spaces, learning across contexts and learning with mobile devices, in learners' point of view. Mobile technologies can enrich how learners collaborate by providing devices capable of moving with learners, making technology available anywhere and any time.

Most of the collaborative applications require an Internet connection. Those applications use client-server architectures as they are web-based. New communication standards such as the Mesh networks allow distributed architectures when building collaborative software. This architecture enables us to tackle the problem of collaboration without Internet connection. In this chapter we analyze design differences between authoring tools for regular computers (desktop) and for mobile platforms. We also discuss some advantages and drawbacks of Mobile Learning platforms and how they can enhance collaborative working. We focus on the synergy provided by a mobile platform and a non centralized network architecture. The Sugar graphical interface – designed for the OLPC initiative – is taken as an example of a collaborative software set with distributed network architecture.

2. Background

From the Pedagogical perspective, authoring is the process to make students use media to produce content. In technology-enhanced environments, digital authoring tools are means to allow learners to express their ideas. Naismith and colleagues (2004) have classified learning activities into six categories: Behaviourist, Constructivist, Situated, Collaborative, Informal and lifelong, Learning and teaching support. They did not considered this taxonomy mutually exclusive; categories are briefly described bellow.

- *Behaviourist paradigm*: learning is a result of a stimulus-response process, it is shaped through positive reinforcement or negative reinforcement in responses. When authors apply the taxonomy to educational technology, problem presentation is considered the stimulus and learner's solution is the response in computer-aided situations. Theorists: Ivan Pavlov, Burrhus Skinner.

- *Constructivist paradigm*: this approach states that learning is an active process. People are viewed as information constructors as both current and past knowledge are used to construct new concepts. Thus past experiences are important to the understanding of new situations. In a constructivist learning environment, students should be stimulated to discover new concepts. Authors consider participatory simulations a very good implementation example of technology-enhanced environments based on the constructivist theory. Theorists: Jean Piaget, Jerome Bruner, Seymour Papert.

- *Situated paradigm*: learning is viewed as a part of social interaction processes; this theory requires learners in authentic contexts and culture (can be unintentional instead of deliberate) and their participation in a community of practice (a group dedicated to do something and learning how to improve their practice through interaction). Instructors working with this paradigm should provide situations where learners can get in touch with real problems even before they have a complete understanding of it. Authors consider mobile technologies can enhance context because they can be present in different situations. Theorists: Jean Lave, John Seely Brown.

- *Collaborative paradigm*: learning is also emphasized as a part of a social participation process; interaction is a key component of this learning paradigm. Learning is a reciprocal experience that can be described as conversations between learning agents (students, teachers, technology devices), learners could converse with another agent to share an understanding. This paradigm includes CSCL (Computer-support Collaborative Learning); technology has to support these interactions and enhance communication possibilities. Theorists: Lev Vygotsky, Andrew Gordon Speedie Pask.

- *Informal and lifelong paradigm*: learning is considered not to be confined to the classroom, it takes place throughout life. This learning is often informal, specially for adults. Technology should support people to learn anytime and anywhere, assisting them in intentional and unintentional learning episodes. Theorist: Michael Eraut.

- *Learning and teaching support*: these are activities related to administration, classroom management and reviewing and assessment. Authors argue that technologies are not restricted to support learning activities.

From these paradigms, we detach the constructivist, the situated, the collaborative and the informal and lifelong ones. They share some principles such as learner-centric approach and importance of interaction between learners. A learner-centric approach suggests technologies should be *personal*, and supporting interaction between learners requires *network capabilities* from these technologies.

Sharples (2000) analyzed the requirements for lifelong learning technologies. Their design should consider new variables:

- *portability*: available wherever a learner needs;
- *individual use*: able to support personal learning and adaptable to personal abilities and needs;
- *unobtrusiveness*: technology should not obtrude on the situation;
- *availability*: provide communication with learners and teachers;
- *adaptability*: technology should be context sensitive and evolute according to learner's knowledge;
- *persistence*: learner's productions should be available despite of changes in technology;
- *usefulness*: suited to everyday needs for communication, reference, work and learning;
- *intuitiveness*: easy to use even if one has no previous experience.

In the next sections, we will analyze how authoring and collaboration are related to these requirements and educational paradigms.

3. Authoring, Collaboration and Digital Tools

Authoring is a key component of Constructivist activities. Papert argues that part of the learning process is about collecting information, by reading books, listening to teachers or visiting websites. Another part of learning "is about doing things, making things, constructing things" (Papert 1999); if doing so, students are constructing their knowledge. In school context, instructors should stimulate students to discover principles.

This attitude change transforms learners from information recipients to "active constructors of knowledge" if provided with the appropriated tools (Naismith et al. 2004). Papert uses the word Constructionism to refer to this idea of "learning by making" when learners play an active role in the learning process (Papert 1999). This is a rationale for producing relevant digital authoring tools.

The ability to create things using computers is a important issue for the future society. Resnick (2002) considers computers are the most powerful creation tool invented. Nowadays, people have daily contact with digital technologies in office environments and also in everyday activities. Computers decreasing costs are making they available to a wider public, reducing the digital divide in terms of access to technology.

But access itself does not warranty the digital fluency needed to face some of the future challenges. Education through lifetime and continuous self improvement are considered fundamentals to improve oneself in a knowledge-based society (Magalhães et al. 2009). Digital fluency is not about using the computer, but knowing how to express oneself using it (Resnick 2002).

The Computer Clubhouse project aimed to address the problem of digital fluency for young people. While frequenting those clubhouses, people are encouraged to create things such as games, simulations, music or websites using computers. This project stimulates authoring to make youth more confidence as learners; Resnick (2002; 2003) provide a more detailed description of the project and its strategies.

Collaborative learning takes place when a learner converses with another learning agent to exchange learning experiences. Sharples (2002) argues successful learning is a constructive process, where conversation takes a central place. Conversation is the communication between knowledge systems (students, teachers or technologies) about what one knows. In this point of view, the importance of collaboration in the learning process is to question and to be questioned about one's concepts and interpretations. Collaboration can be defined as the "co-construction of knowledge and mutual engagement" of peers, configuring a "special form of interaction" (Lipponen 2002).

Dillenbourg (1999) sees similarities between individual and group cognitive systems. He does not considers people "learn from collaboration". A single person does not learn simply for being an individual; and similarly, peers in a group cognitive system do not learn from the simple fact they are more than one person. Dillenbourg points the activities performed by learners (such as reading) are actually responsible for triggering "learning mechanisms" (like induction and deduction). When in a group, peers still perform some of the activities they performed individually, also triggering the learning mechanisms. But the interaction with others brings new activities (like explanation and discussion) and activates new learning mechanisms (such as knowledge elicitation, internalization and appropriation).

Computer-supported collaborative learning (CSCL) studies how "technology can enhance peer interaction and work in groups, and how collaboration and technology facilitate sharing and distributing of knowledge and expertise among community members" (Lipponen 2002). CSCL is a collaborative situation and it triggers these learning mechanisms since it can be viewed as a contract between the peers, or between peers and the teacher (Dillenbourg 1999). Dillenbourg also highlights that we expect a particular interaction to occur among people in collective situations, but there is no warranty they really will nor the corresponding learning mechanisms will be triggered.

4. Mobile Learning

Mobile technologies enable teachers and learners to create different learning settings, which are not restricted formal learning environments. From learners' point of view, learning can be classified as mobile in three ways (Vavoula & Sharples 2002):

- across contexts: one could learn from a work demand or from leisure;
- across spaces: learning could place at home, at working offices or at theme parks;
- across time: learning could happen at different periods of the day, does not matter if it is a weekend, working day or holiday.

Mobile learning also focuses on learning using mobile technologies; making technologies available anytime and anywhere can improve learning situations. Authoring and collaboration are compatible with Mobile Learning practices (Naismith et al. 2004). By considering physical mobilities of learners we can enrich ways learning activities are performed. Learning experiences can be enhanced by allowing study in places where it would not be possible before (Bull et al. 2005).

A classification of technologies using two axis (personal-shared, portable-static) was provided by Naismith and colleagues (2004, p.7); this classification is shown at figure 1.
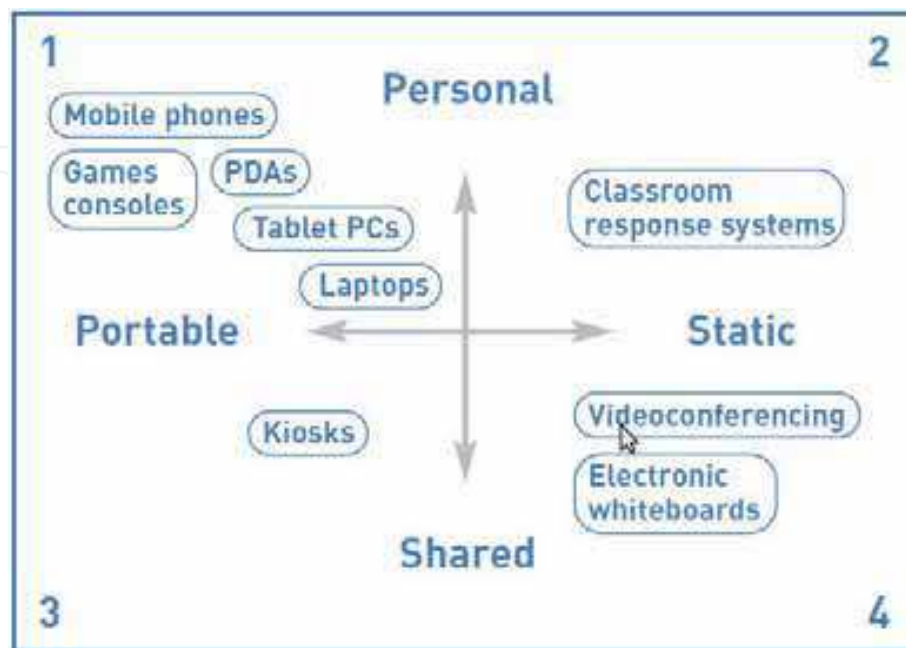

Fig. 1. Classification of mobile technologies (Naismith et al. 2004).

This classification helps us to identify how platform mobility, learner mobility and device sharing affect learning experiences. The 1st quadrant shows personal and portable devices, such as mobile phones, laptops and hand-held video games; these are the mostly common devices associated with the term "mobile technologies". The exemplified devices are usually networked, allowing communication among other devices and information sharing. Although these portable devices are strongly personal, their information can follow a more shared fashion (Naismith et al. 2004).

Quadrant 2 shows personal static technologies, such as classroom response systems (students can answer multiple choice questions using these devices). Interaction still personal as it is destined to a single user , but technology could not be carried out classroom, so it is static.

Third quadrant represents technologies that provide learning experiences to moving learners using non-movable devices, as "being physically moved from one place to another is not the only way in which mobile technologies can be portable" (Naismith et al. 2004, p.8). Interactive museum displays are an example of those; they provide access to information to a changing audience. Thus the portability refers to the learners not to the technology. Still, these devices are typically used by more than one person at time, which classify them as shared.

The fourth quadrant shows devices with more sharing characteristics for their larger sizes.

An example would be a video-conference facility, that can be used by many people at the same time and cannot be moved around. Naismith and colleagues (2004) consider mobile technologies as those included in quadrants 1 to 3 and those from quadrant 4 that are not extremely static.

Sharples and colleagues (2002, p.233) consider mobile learning resources "should, ideally, fit seamlessly into this complex pattern of learning opportunities and resources". There are some key issues for technology developers and educators on planning successful mobile learning environments (Naismith et al. 2004):

- Context: gathering and utilizing contextual information may clash with the learner's wish for anonymity and privacy.
- Mobility: the ability to link to activities in the outside world also provides students with the capability to 'escape' the classroom and engage in activities that do not correspond with either the teacher's agenda or the curriculum.
- Learning over time: effective tools are needed for the recording, organization and retrieval of (mobile) learning experiences.
- Informality: students may abandon their use of certain technologies if they perceive their social networks to be under attack.
- Ownership: students want to own and control their personal technology, but this presents a challenge when they bring it in to the classroom.

Context is one the most important issues, as mobile learning is intrinsically more driven by context than classroom (Sharples et al. 2002). Moreover, mobile technologies are primarily computers but the characteristics outlined above suggests they support different activities that desktop (typically shared and static) computers currently do. Mobility of learners and devices encourages new practices, also supporting new interactions between learners and the environment (Naismith et al. 2004). These mobile technologies can also lever learners' to connect different contexts, helping to "form bridges between formal and informal learning" (Kukulska-Hulme et al. 2009).

There are many Mobile Learning initiatives around the world. The MOBILearn was a 33 months-long project to propose and evaluate an architecture for mobile learning. The ENLACE project designed and implemented a technical infrastructure to support collaborative learning activities inside and outside school. The *Mystery at the Museum* project used mobile devices to improve students engagement in museum activities using a game-based approach. Kukulska-Hulme (2009) and colleagues provide more details in those initiatives. The next section will present the OLPC project in a mobile learning perspective.

5. OLPC and Mobile Learning

The One Laptop per Child project (OLPC) aims to create a laptop inexpensive enough to be sold to children around the world. This would allow the creation of opportunities for "world's poorest children by providing each child with a rugged, low-cost, low-power, connected laptop with content and software designed for collaborative, joyful, self-empowered learning" (OLPC 2009b). As an Education project, this is clearly a Mobile Learning initiative.

The OLPC project began in the late of 2005 and has levered the development of the today's Netbooks (Bajarin 2008). The OLPC initiative is probably the first large-scale effort to design this new class of laptop focused on low-cost and low-power consumption. Another highlight of this initiative is to be completely based on open source solutions; the openness is such that even the user is able to see the source-code.

The OLPC laptop is called XO and the graphical interface was named Sugar. The hardware was designed to be inexpensive and reliable even under adverse environments conditions. The Sugar environment is based on the Constructionist theory, so Sugar the software set is mainly composed of collaborative authoring tools (Martinazzo et al. 2008; Sugar Labs 2009). The applications are called "activities" in the Sugar interface; they use verbs instead of nouns such as "Write" for the text editor, "Paint" for the drawing application and "Record" when referring to the activity that accesses camera and microphone.

The XO hardware provided some innovations such as Mesh Network (IEEE 802.11s) compliance, low consumption and a sun-light enabled display. As pointed by Syvänen and colleagues (2005), the uncontrolled places learning can happen affects availability an quality of online services and tools. This can be a constraint for network sharing and computer-mediated collaboration, although it could encourage learners to establish their own learning places.

XO's hardware specification combined with Sugar's interface guidelines has forced application developers to rethink some design decision such as architecture and interface. Sugar activities are free software; some of them were built from scratch but most of them are actually desktop applications re-designed to fit Sugar's requirements. This is mainly due to the collaboration supporting and adaption to the Journal system. This Journal system is an innovation proposed in the OLPC project that allow learners to access the files created without referring to the file system directly. Instead of that, one does not handle with files, but with objects and people. The Journal records every interaction with the laptop keeping a history of the things the child has done and the activities he or she has participated (Martinazzo et al. 2008; OLPC 2009a).

Sugar also uses a new metaphor to organize the graphical interface and display information. The Desktop metaphor is not appropriated for learning environments (Sharples et al. 2002) and other metaphors and system images must then be created to make interaction more recognizable. Sugar is based on the Zoom metaphor, which reflects the collaboration idea (Martinazzo et al. 2008).

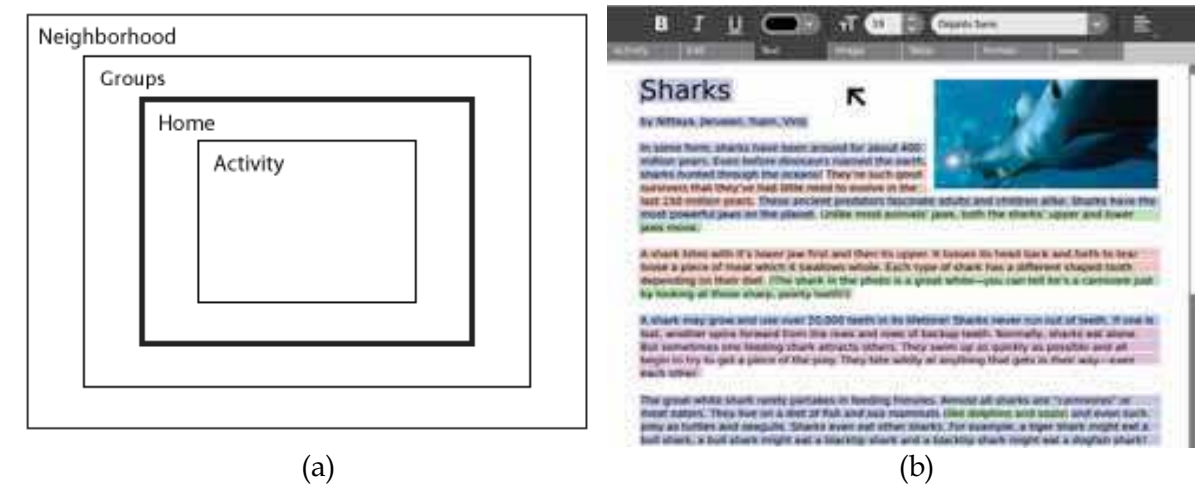(a)   (b)

Fig. 2. (a) Sugar's Zoom metaphor; (b) the Write activity.

Figure 2 shows the Zoom metaphor proposed in Sugar and one of its activities. The zoom has four levels named Neighborhood, Groups, Home and Activity, from the broader level to the closest one.

The Neighborhood shows other XO connected to the network, and what activities they are participating. Groups view represents learner's friends, classmates and other groups he/she belongs to.

Home level allow activity switching, check network connectivity and laptop status, for example. This is the view that most resembles a Desktop environment. Activity is the latest level and it display the current performed activity. Not displaying any other activity was a design decision that allows viewing a single activity in full screen mode.

This rupture in graphical interfaces is also observed in some GNU/Linux operating systems for Netbooks. Network-oriented operating systems like Moblin[1] and Android[2] will soon be available at the netbook market.

The Sugar architecture provide a framework creating collaborative authoring software based on DBUS[3] and Telepathy[4]. This combination (also called D-Tubes) provides a Remote Procedure Call (RPC) and an event-oriented framework through the Mesh network. DBUS itself takes care of process communication and Telepathy handles friends identities and message passing through firewalls. The Telepathy features are responsible for the Neighborhood an Groups view in Sugar's Zoom metaphor. D-Tubes facilitates the integration with XO's activities and other GNU/Linux applications, since D-Tubes are available to many platforms. The Sugar framework allow the creation of decentralized collaborative software, ie, the client-server model is not necessary.

6. Design Considerations

We consider personal and networked technologies are able to support constructivist, informal and lifelong, collaborative and situated learning activities. Mobile technologies are also very well suited for context-aware applications.

A system composed of interconnected mobile devices can be modeled as an distributed memory system. In a distributed memory system, each processor can only directly access its physically associated memory (Chandra et al. 2001, p.8). To access information stored in other nodes (processors), devices must explicitly pass messages through the connecting network. The developer is responsible for managing data exchange between nodes. As commented before, the D-Tubes framework aims to provide an easier programming model using events and a distributed architecture.

Comparatively, desktop computers have more computational power and usually improved graphics; these allow more complex and CPU-intensive applications in such platform. That kind of computer also is likely to be used as a shared resource and does not provide physical mobility itself. So when designing an authoring tool for a environment with desktop computers, it is important to analyze whether there will be people on the move or settings will be in a static fashion. The later case allow us to explore mobility across time (considering a static technology with people on the move). This can help designers to develop task models.

Mobile devices usually have simpler input systems due to their small sizes, although they are not exclusive of mobile devices. Examples of these input systems are numerical keyboards, touch screens, accelerometers and voice commands. Certainly a authoring tool

for a mobile device would not have as many features as one to desktop computers could, but the mobile software can take advantage of being present in different contexts (considering learner's mobility).

The input system is a very important difference between authoring tools designed for desktop and mobile computers. Whilst desktops provide more complex inputs (such as long texts using keyboards and peripherals, like joystick, mouse and cameras) and consequently allow richer productions, mobile devices have the advantage of portability: learners can carry them out and use in everyday situations. Even though the productions made with mobile devices are simpler, they keen characteristic is to be context-aware, this is important for linking formal and informal learning situations, as highlighted by Kukulska-Hulme and colleagues (2009).

The OLPC innovations brings the Journal as a unique feature to manage one's productions. Not dealing with files and folders can be a great advantage for young kids, since it was designed to resemble human memory (OLPC 2009a). The whole OLPC project is based on the one-to-one hypothesis; in other words, the XO is a personal device. The network capability makes these devices more powerful, since learners can experience collaboration even without an Internet connection.

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1 For more information, see http://moblin.org/.

2 For more information, see http://www.android.com/.

3 For more information, see http://dbus.freedesktop.org/.

4 For more information, see http://telepathy.freedesktop.org/.

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The education industry has obviously been influenced by the Internet revolution. Teaching and learning methods have changed significantly since the coming of the Web and it is very likely they will keep evolving many years to come thanks to it. A good example of this changing reality is the spectacular development of e-Learning. In a more particular way, the Web 2.0 has offered to the teaching industry a set of tools and practices that are modifying the learning systems and knowledge transmission methods. Teachers and students can use these tools in a variety of ways aimed to the general purpose of promoting collaborative work. The editor would like to thank the authors, who have committed so much effort to the publication of this work. She is sure that this volume will certainly be of great help for students, teachers and researchers. This was, at least, the main aim of the authors.

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