Scenarios for Mobile Learning across Contexts

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Abstract: Mobile learning has been described as learning across various contexts, but the situated potentials of different contexts for learners and resulting requirements for learner-centered system design have rarely been considered. We discuss design challenges and opportunities of portable technologies to support learning activities inside the classroom and outside across various contexts.
A functional software prototype for interactive whiteboards, and pen-tablets and PDAs has been implemented in order to support learning activities in the classroom, at home, and in the wild. Futures workshops have been conducted to sketch out additional scenarios for mobile learning applications, named Pattern Collector, Natural Ideograms, Contextual Windows, Augmented Tourguide, Mobile Library, and Wiki School. Drawing from psychological and pedagogical theory we explore their unique potential to support learning across contexts. Their contrastive discussion indicates different notions of context and indicates new directions for designing learner-centered systems.

Keywords: Educational Technologies, Mobile Learning, Learner-Centered System Design, Interaction Design Patterns, Scenario Prototyping, Learner-Generated Context

1 Introduction

Mobile learning has been described as learning across various contexts, but the situated potentials for learning in different contexts, and resulting requirements for learner-centered system design have rarely been considered. Besides research and development of educational technologies has mostly focused on online and mobile media rather then on an integration of classroom, mobile and online media involving different instructional methods. This paper focuses on theoretical challenges in the development of educational technologies to support problem-oriented and collaborative learning activities inside the classroom and outside across various contexts.
Form factors and technological capabilities of new systems and devices need to be matched with educational theory and didactical concepts to provide suitable support for learners. Different scenarios for the application and extension of these patterns within mobile systems and their integration with online and classroom activities are being described and illustrated. The initial Pattern Collector, a system to learn ideograms in their natural environment, windows and a mobile tour guide to augment sights with contextual information, a mobile library providing a comfort zone for mobile learners and a wiki-school providing an open source for educational media and instructors. Their comparative and contrastive discussion indicates different notions of context, design challenges and didactical affordances for mobile learning.

2 Related Works

Other than user-centered design learner-centred design has the goal to support learners in developing a better understanding of a yet unknown practice. Tools not only need to support completion of a given task but to enable the acquisition of knowledge for diverse audiences and changing scaffolds. With respect to mobile learning portable devices have been discussed as a valuable means to support the context-dependent construction of knowledge (e.g. in Jippling et al. 2001). Especially their ability to collect data, work collaboratively and location awareness are suited to create uniquely new learning opportunities (Patten et al. 2006). Handhelds have been described as 'flexible tools that can be adapted to suit the needs of a variety of teaching and learning styles' (Curtis et al. 2002). But usage of portable devices does not suffice for mobile learning.

In the learning sciences peripheral participation in professional communities of practice has become a definition of "situated" learning (Lave & Wenger 1991). Taking part first peripherally in such professional communities participants learn while subsequently growing into more central positions. In (Vavoula 2004), informal learning is described as a process of learning that occurs autonomously and casually without being tied to highly directive curricula or instruction. The same work presents a typology based on the presence of and control over the goals and the process of learning. In supporting informal learning situations, handhelds have been used to collect data in the field (Scanlon & Waycott 2005), and to consult information from a remote server or a nearby data-source, as is the case of using PDAs in museums.

Different notions of context are most crucial for any discussion of mobile learning, and its educational methods and media. "Mobile learning is not just about learning using portable devices, but learning across contexts" (Walker 2006). Various constructs of learning context in mobile HCI (such as socio-cultural factors, location, and activity, content and user context) have been briefly summarized in research by Winters and Price (2005). Besides the classroom setting informal learning environments with peers within natural environments and individual learning sessions are being considered.

Within our own research on educational technologies inside and outside the classroom, we developed a system for touch-sensitive mobile devices that allows for the collection, annotation and collaborative exchange of visual and written data, and for transferring these field notes for further elaboration at home or discussion in the classroom (Breuer et al. 2007). Its interaction principles such as gesture-based interaction on touch-sensitive devices apply the same design modules as we already implemented for pen-tablets and whiteboards inside the classroom, allowing for a seamless transition between formal and informal learning environments.

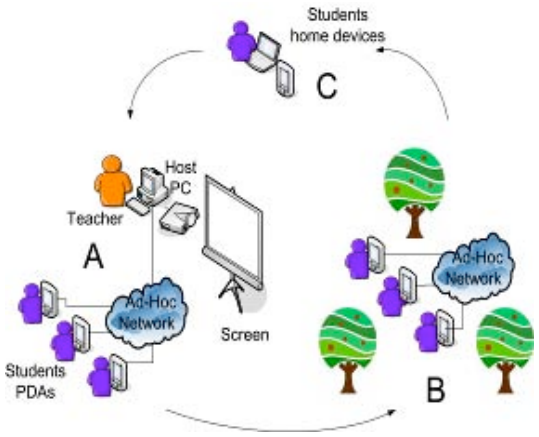

Figure 1. PDAs provide for a unique interface and a seamless transition between the learning environments of the classroom, outside "in the wild," and at home.

3 From Patterns to Scenarios

In order to allow students to focus on learning activities within these different setting an interaction design pattern language has been developed and implemented on different portable devices: PDAs, interactive Whiteboards, pen-tablets and tablet computers. On each of these devices students start with an open space to generate, collect and exchange resources for learning. Gesture-based interaction allows them to flexibly create and organize content within a hierarchical semantic. Individual and group awareness widgets support communication and collaboration between peers and teachers. Considering the potentials of defining patterns on levels of increasing generality, the outline of the pattern language differs between the levels of didactics, curricula, activities, actions and operations (Breuer et al. 2007).

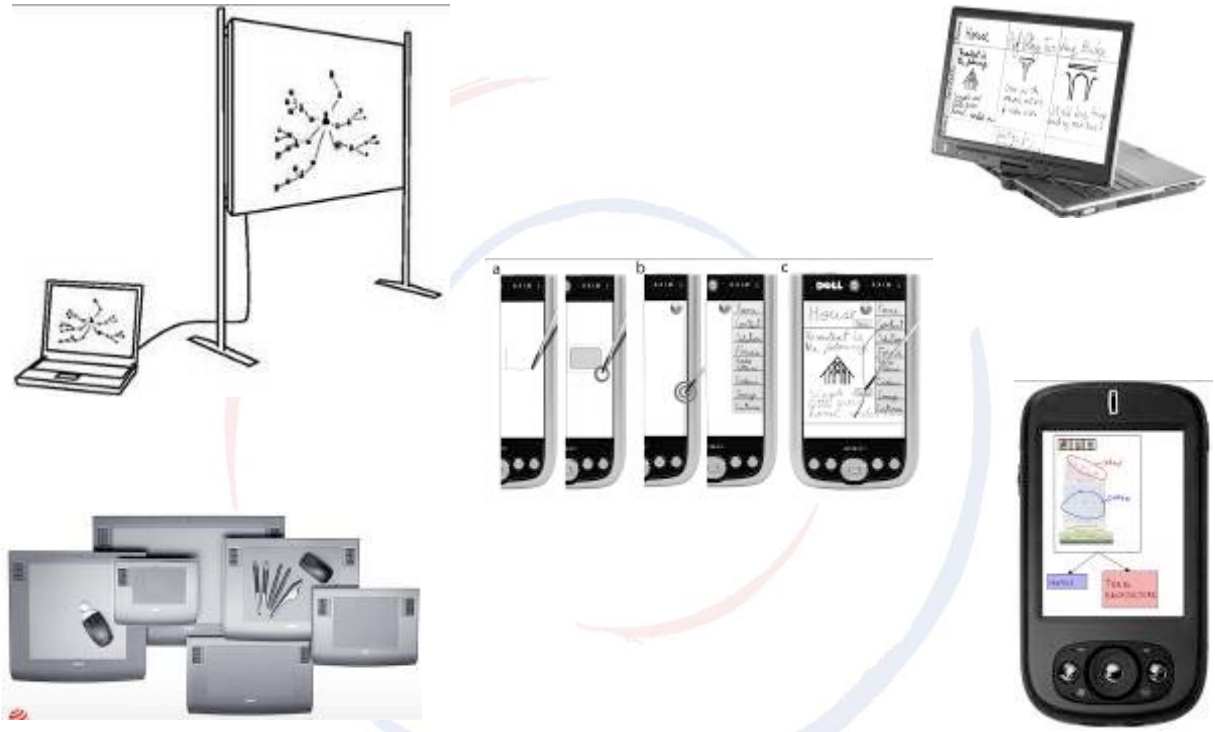

Figure 2. A range of devices supporting similar interaction patterns.

The system was enriched by a set of templates that allows students to collect examples and observations of interesting design solutions using PDAs and documenting them as potential design patterns with a name, problem description, solution, example (as found in the field) and reference to other patterns. These potential patterns may then be transferred home or into the classroom for further investigation and discussion. In order to specify application fields the following usage scenario for a "Pattern Collector" has been developed:

Within the classroom, students and teachers work together on a particular subject like modern architecture using the Pattern Collector. The teacher may prepare an initial presentation introducing the field and point out some problem, like the conflict between the planning of a static structure and the inhabitants' appropriation of that space, which may be defined in terms of usage patterns. Afterwards students are asked to collect examples of best practices in the city regarding an illustrating topic such as "entrances and exits". Students then explore their neighborhoods, taking pictures of felicitous examples of door design, with the functional and aesthetic context of the door, the door itself and its component details. Subsequently, they may comment upon what they see using the pattern format and adding extra (e.g. online)

material and references at home. In case of doubt if a certain appropriation of space represents a usage pattern, they may connect to other students in their group debating their point of views. Communication functionalities and a shared view on the handheld provide a common anchor for reference. Back in the classroom, each group sends their findings to the interactive whiteboard and discussions continue. Moderated by the teacher, students evaluate their propositions and discuss the hierarchy, its distinctive levels, and the relations between the patterns they intend to work with in order to collaboratively create their own pattern language. Design and architecture students would then go on to apply their own patterns by building models that represent ideal representations of these patterns and pattern languages for a specific context. In the end, they will not only have learned how to extract and work with patterns, but will have also addressed critical issues and trade-offs in the specific field.

Figure 3: Pattern Collector (Breuer et al. 2008)

Illustration and application of theories are commonly considered to be essential for developing a thorough understanding. Furthermore, exercising appears critical to define the scope and boundaries of theoretical approaches. In traditional classroom settings extensive exercises are rarely conducted. Two factors may contribute to this phenomenon. Firstly, individuals differ greatly in the amount of exercise needed and tolerated. Thus, while some students may appreciate the opportunity to exercise others get bored more easily. Secondly, it is very time-consuming for a teacher to collect diversified materials that maintains students' interest. The scenario outlined avoids both problematic issues. Taking into account differing needs, it allows students to decide individually how much exercise they need, e.g. by commenting more or less frequently on their peers' solutions posted in online forums. Furthermore, the photographs gathered by students are likely to be much more diverse and to address issues more relevant for individual comprehension than photographs preselected by the teacher.

4 Scenarios

The usage scenario previously described provides a starting point to dive deeper into futures scenarios for mobile learning that have not yet been implemented. As speculative design scenarios provide a first references to explore and advance design alternatives. In our case they are situated on a plane of imagination, where alternative syntheses of desirability and feasibility are being projected in order to provide orientation. They may serve as provide "just-enough prototypes" and references to explore, discuss and contrast potential directions and implications of the development of learner-centered mobile systems. According to Alexander (2004) they describe sequences of actions at the starting point of systems design on various levels of granularity. Within strategic foresight and management scenarios have been

widely used to inform decision making and trigger organizational learning (Fink et al. 2000). Scenarios contain rich descriptions of potential developments.

The following scenarios have been created within futures workshops on mobile communication and learning. In principle, a futures workshop can be interpreted as a catalyser for reducing the discontent with the current situation and for showing positive development possibilities for the future (Jungk & Müller, 1987). A futures workshop typically includes domain experts from separate fields and consists of phases for critique, utopian imagination and realization. The scenarios are described with a name, a didactical approach, the media & features applied potential application fields, a short scenario story and a context.

4.1 **Natural Ideograms** (Breuer & Matsumoto, 2008)

This scenario aims at self-directed learners in informal learning environments. A mobile device with camera and access to sign recognition is needed. Some intelligence on behalf of the system is required for identification, disambiguation and translation.

A user may read signs or text written in foreign languages as input via a mobile camera. Software within the portable device translates the sign into the users' native language offering an interpretation of its contents. If we consider that the purpose of public informational signs is to provide both information and orientation, we may even propose a system that does not only utilize sign recognition and translation capabilities of a mobile system, but public signs providing a unique identifier (like a QR-Code or Bokode) that is unambiguously detectable by a mobile system.

A picture of the sign and its surrounding context may then be saved together with the translation, creating a personal history of the users' encounters with new signs. This information can then be collected on a file card and be used later for studying the translations. In fact, hints related to the meanings of pictures may be included on file cards so that users can exchange information with other users, contributing to a kind of quiz game (introducing an aspect of social mediation). Similarly, a teacher may invite students to collect pictures for a vocabulary competition in class.

Figure 4. Natural Ideograms (Breuer & Matsumoto 2008)

This scenario may not only support people who visit a foreign country to learn the respective language but may also imitate these conditions for people who are in their native country. Learning occurs almost automatically in natural contexts. Progresses are made more rapidly since contextual embedding of vocabularies facilitates recollection. To associate new vocabularies with personally significant information strengthens memories even more. Additionally, contextual embeddings safeguard against misinterpretation of literal translations. According to a well documented phenomenon retrieval of information is facilitated if the context in which a lesson has been learned is reinstated (e.g. Godden & Baddeley, 1975,

1980). Thus, pictures of a situation encountered should provide useful hints for recalling the respective word, encouraging the learner in turn. All in all, the scenario is considered particularly useful for language acquisition. In contrast to traditional vocabulary exercises situated personal meaningfulness should contribute to an enjoyable learning experience. Certainly, there are standard vocabulary exercises that provide contextual information to the learner, such as presenting a photograph of a bank along with a list of financial words. These exercises allow applying mnemonic techniques (e.g. by encoding spatial arrangements, however, time information is usually not provided) and to derive hints for rehearsal as well (like "what was the boy taking out of his wallet?"). However, these standard exercises differ in two ways from the scenario suggested. Firstly, the learner may not decide by himself which vocabularies he considers useful to learn. Additionally, the contextual information (i.e. the picture or photograph) does not relate personally to the learner. Within the scenario on the other hand personal relevance is mediated by contextually situated usefulness.

4.2 Mamama – Multimodal Chinese

Suitable for formal training as well as for edutainment games another tool for language acquisition was lined out in an ideation workshop on use cases for 3D gesture recognition by means of a magnetic ring (Ketabar et al. 2010). A starting point was the difficulty to learn tonal languages. In Chinese tones are distinguished by their shape and pitch range, and many words are differentiated solely by tone. Other languages like Japanese make use of pitch accents or phonemic tone to give prominence to syllables within words changing their meaning. Thus, applying the right tones is quite important language acquisition. In Chinese for example a "ma" may signify "mother", "horse", or a "question mark" in Chinese, depending on a rising, declining or bilateral intonation. The scenario utilizes physical gestures of the hand (e.g. wearing a magnetic ring with a mobile device) for foreign language phonetics acquisition. Thus, another kinesthetic modality of learning vocabularies is made accessible. This allows learners to either select one mode of presentation (acoustic, verbal or gestural) according to their own preferences or to use all likewise leading to an in-depth processing to achieve a mnemonic advantage. If anything "context" is here the tonal system.

4.3 Augmented Tourguide

Suitable for the same didactical approaches and media like the natural ideograms scenario the augmented tourguide augments objects and sights in natural settings. Its basic technology for visual search is already available as prototype developed by Google (http://www.google.com/mobile/goggles). The augmented tour guide provides visual and audio information on places and objects you see or target with your mobile device. One mode may be a "timemachine", with which a user can visually travel back and forward in time to access documented material about his or her surrounding or to get information about upcoming events. A metadata visualizer adds content provided by others, e.g. on what is happening inside a building. Interactive online games mix the real and the digital world.

Figure 5. Scenario for an Augmented Tourguide (Illustrations by Gabriele Heinzel)

The augmented tourguide may be used as a supplement of GPS-guided tours that are published on www.geocaching.com by way of example. By now, more than a million caches have been hidden worldwide for this treasure hunting game. One target group may be tourists who visit an unknown place. They may follow the tour recommendations posted by geo-cachers who know the area quite well and carefully elaborated a tour that guides strangers alongside notably places. Guidebooks provide similar services to the well-prepared traveler. However, reading about a place or object distracts from inspecting it. Furthermore, utility might be impaired if guidebooks are out of date or of low quality which is usually not noticeable to strangers. In contrast, the augmented tourguide is easily updated and evaluated by users who elaborate and comment on information and recommendations. Additionally, it may meet the special needs of people on a business trip who did not plan their journey beforehand but unexpectedly find themselves to have a few hours of spare time to spend. Relying on GPS makes it possible to start the tour at any location without looking for a starting point first.

4.4 Contextual Windows

Whereas the previous scenarios address individual learners with their portable devices the next one utilizes public screens of transport systems to convey information and learning content. Travelers within public transportation systems, such as riders on trains and trams, may be unobtrusively provided with contextual information on a half transparent screen within the coach. The display screen could be implemented by an organic light-emitting display (OLED) or the Quick Response - Liquid Powder Display (QR-LPD). Images on the screen with silhouettes of buildings or objects would not replace the views of the real objects, but add a layer with "contextual" information on local reference points, such as the history of the passing neighborhood or building, current political issues that relate to the place, aesthetic highlights, obscure anecdotes, etc. Via touch screens or settings on their mobile devices, travelers may select from different kinds of information. Alternatively, some general information about currently popular exhibitions and events in the vicinity may be retrieved.

As a scenario we may imagine passengers seeing the abstracted picture of the entrance to a large Berlin church on the window as they are passing by. Listening to their audio handsets, they may hear something such as the following: "On the right you see Gethsemanekirche. In the peaceful revolution of 1989, this was a central meeting point for the East German opposition …" If they want to retrieve further information, the handset allows them to browse related online content. This again might be shown on the public screen or saved together with an image of the scenery on the mobile device for in depth follow-up study. Connecting such systems to already existing recommender systems and social networks may contribute to reunite the separate worlds inside and outside the classroom.

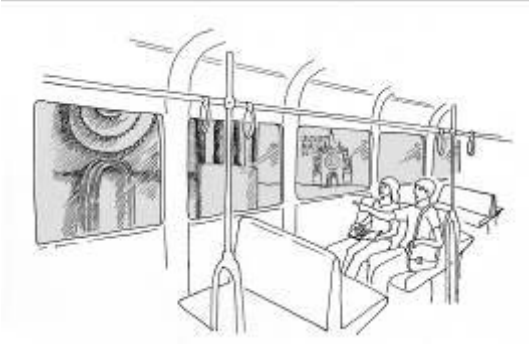

Figure 6. Natural Windows (Breuer & Matsumoto 2008)

Whereas infotainment screens positioned in metro stations offer updated informational services to passengers they provide all passengers with the same news. In contrast, the scenario outlined allows passengers to navigate the display screens deciding whether and which information they would like to get (e.g. by choosing one of different categories, such as general information, architecture, culture, history). As a positive side effect, passengers sharing a suite are encouraged to interact, since they need to find consent on their informational requests. Exchange with social partners may be facilitated further through a community board function that allows passengers to add comments and leave their own traces.

4.5 Mobile Library

The mobile library preserves aspects of formal learning environments within mobile settings and intends to support self-directed learning activities during commuting times. It utilizes tablet computer with camera and gyro sensor in order to create a personal or shared space for learning.
Within a futures workshop at the University of Applied Sciences Potsdam current obstacles and utopian futures of mobiles learning laid the grounds for envisioning new systems to support mobile learning for public transport. The necessity of a "comfort zone" for learner became a central topic during the workshop. During commuting times people often find themselves in stressful states, coming across crowds of people, alternating between natural and artificial daylight when using the metro, potentially encountering loud noises and malodors. A certain limit of sensory information is exceeded awkward sensations result. Many people cope with this stimulus overload by secluding themselves, blending out the environmental changes, e.g. by wearing earphones. Another way to restore comfort might be to provide familiar cues associated with a relaxed context. Thus, the envisioned system provides a personal library with spaces, books, desks to sit down and write and read on, staff to ask how to advance, and other rich resources organized by physical location. A gesture-based handling of tablet computers was proposed in order to create an adaptable and comfortable personal learning environment with individually adaptable and familiar modules. Moving the tablet or pad to one side yields access to books whereas a horizontal posture provides for a desk with notebooks, pens and brushes.
Such a system might be interesting to all commuters who would like to exploit traveling times for work but do have problems to concentrate or just do not feel comfortable due to stimulus overload. Inducing some sense of familiarity is expected to have positive and relaxing psychical effects. Furthermore, all work materials are still accessible and they do not need to be rearranged to adapt to the new environment. Thus, this scenario could provide more agreeable and more efficient working conditions. Its motto: Bring your own context!

4.6 Wiki School / Wikiversity

The last scenario addresses any kind of didactical approach and media. While the previous scenarios mainly delivered content the generation of such content and its didactical formation becomes an essential element here. The idea was developed within a futures workshop on use cases for mobile communication. Websites like Wikischoll or Wikiversity (http://www.wikischool.de/wiki/Hauptseite for students, http://en.wikiversity.org/wiki/School education for teachers) provide similar information but no advanced functionality or interactive learning environments.
The idea was motivated from the utopian ideation demanding universal knowledge access, self-directed education, freely available modular (open source) systems, and completes transparency within situated learning activities. The realization was described as a combination of modular online resources for students and teachers with real local facilities e.g.

in remote areas. Everyone interested to participate or contribute can access live and stored online classes and share educational materials in similar ways that Wikipedia provides free encyclopedic knowledge. But such wikischools would not only contain uploaded textbooks and interactive role-playing games, but also provide actionable knowledge, either for teachers to prepare courses for classroom or wildlife settings or for students interested in completing a given task (like building a house with limited resources). Furthermore, recommendations for systematic self-studies (e.g. curricula) may be delivered and remote-tests could be scheduled to get respective certificates. Thus, the Massachusetts Institute of Technology (MIT) publishes its academic course contents on the web (OpenCourseWare, OCW, http://ocw.mit.edu/courses/). Short lessons might be available for mobile learning, but the scenario aims at the ubiquity of knowledge and didactics.

Figure 8. Scenario for a WikiSchool (all illustrations by Gabriele Heinzel)

Similarly to distant learning universities wikischools may be of special interest to students who are not able to visit a school or university regularly (due to physical disabilities, to time constraints caused by another job, to a bad infrastructure etc.). Moreover, all teachers should feel attracted to sharing thoughts and exchanging materials for class, since rapidly changing and nationally predetermined learning goals require much tedious world in adapting materials.

Excellent resources not only including power point slides but instructions for exercises in class, references to multimedia resources, and questions to discuss as well are already provided by publishing companies (e.g. Houghlton Mifflin, Bergmöser + Höller: www.zahlenbilder.de) and national institutions (e.g. Bundszentrale zur politischen Bildung). However, wikischool is supposed to integrate and provide free access to all contents allowing users to evaluate and elaborate on these materials. Experience-based feedback may enhance the utility of contents causing a considerable advantage over costly standard solutions. To illustrate this point, teachers planning practical exercises or highly controversial and emotional discussions in class have to be prepared for escalating conflicts. Some manuals may offer guidelines how to handle such difficult situations (e.g. Houghlton Mifflin). However, for predicting outcomes systematic evaluation of experiences needs to be conducted. Thus, wiki school users may complete short surveys giving feedback about success and failure of recommended exercises. Subsequent statistical analyses will allow finding out "when and why escalations happen" enabling more useful and context-specific recommendations. Consequently, quality of materials is expected to increase with taking into account teachers' and students' experiences.

5 Conclusion: Contrasting scenarios with theoretical notions

The scenarios have been proposed and refined as results from futures workshop in order to transcend discontent with currently available and known educational technologies. The propositions have then been enriched with reference to psychological theory and research results. Looking back across all scenarios different notions of mobile learning and its contexts show up.

Within scenarios like the pattern collector portal devices allowed an **import of natural environments** and a detachment of learning activities from formal settings of education. Collecting data out in the field findings from natural environments were brought into the classroom, and – as in the case of the pattern collector prototype – data exchange enabled an integration of the formerly separated learning environments of the classroom, the home, and informal settings. Accordingly the unique ability of portable devices to collect data has been appreciated (e.g. Patten et al. 2006). Due to their communication features also new forms of collaborative learning and sharing of learning resources have been utilized. Together with the portability of educational technologies and location awareness features context gained importance for the design and experience of learning activities. Still, within most of these scenarios sensory and communicative features do not require "intelligent" information processing.

At the next stage such processing is indispensible for mobile educational technologies. On the one hand learner models are required in order to enable scaffolding. On the other hand technologies like visual search and visual or auditory pattern recognition are needed in order to augment aspects of the natural environment. Scenarios like mamama, natural ideograms, and the augmented tourguide fit into that category. The later systems intend to support **situated learning** and growing understand enabling increased participation. In order to reveal educationally relevant context-dependant information both need to identify aspects of the environment in order to provide for valuable content like background information on sites or translation of written words or signs for means of language acquisition. Even for limited domains like Chinese characters substantial effort is needed to enable systems to decipher sensory (here visual) input in correct ways and to provide the matching content.

The notion of learner-generated context (Luckin 2008) provides a hint how to develop such systems by means of user participation. Focusing on educational resources Luckin (2008) defines learning contexts as ecologies of resources. Ecology of resources is "a set of inter-related resource elements, including people and objects, the interactions between which provide a particular context".

On a third stage we envision a world enriched with **ubiquitous learning** opportunities. Not only pieces of content and single resources may be embedded unobtrusively into everyday settings. Whole lessons, courses, curricula or even development programs may be seamlessly integrated into real world settings. At this stage context is neither something external to be represented internally by some computational model, nor is it the real world context into which a self-directed learner strives to expend his or her participation (Breuer & Matsumoto 2008), but context becomes the learning environment itself as it emerges from the joint engagement of the community of learners. The Wiki-School scenario is an example and metaphor for such an open platform.

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