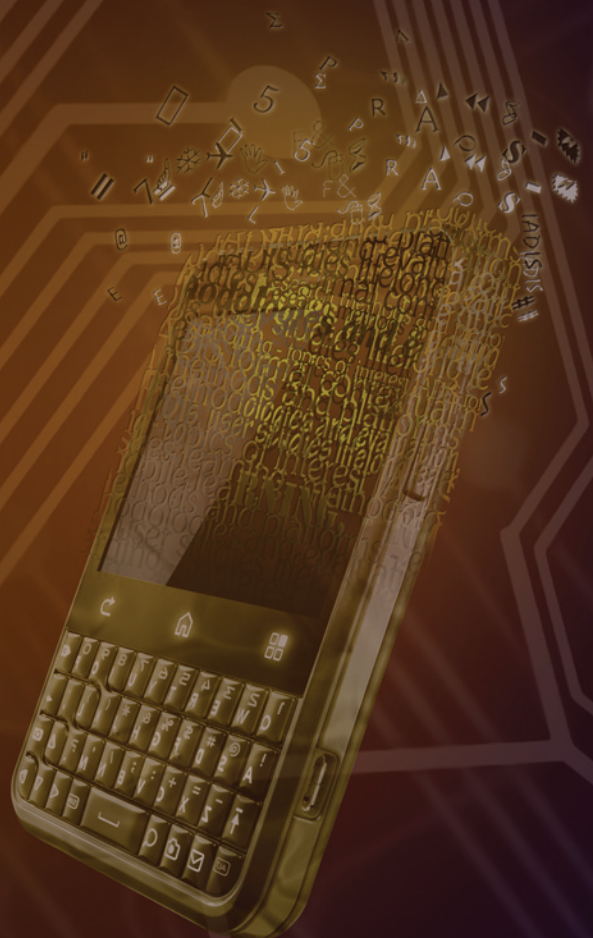


mobile learning

Berlin, GERMANY
11 to 13 March
2012

PROCEEDINGS

Edited by:
Inmaculada Arnedillo Sánchez
Pedro Isaías



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A COMFORT ZONE FOR MOBILE LEARNING – A GROUNDED INNOVATION APPROACH

Henning Breuer, Tillmann Dierichs and Stefanie Elsholz

*University of Applied Sciences Potsdam,
Pappelallee 8-9, 14469 Potsdam, Germany*

ABSTRACT

Mobile learning activities of commuters have widely been neglected. The paper reports on the adaption of a grounded innovation approach involving a futures workshop for interaction design and ideation based on ethnographic insights in the field of mobile learning. Current obstacles and utopian futures of mobiles learning lay the grounds for envisioning new systems to support mobile learning for public transport. A system to enhance comfort zones for mobile learners is being specified and illustrated. It proposes a gesture-based handling of tablet computers in order create an adaptable and comfortable personal learning environment with individually adaptable and familiar modules. An iDesk prototype preserving a personal comfort zone for mobile learners is presented. The system intends to support formal and informal learning in mobile times.

KEYWORDS

Mobile learning, portable devices, ethnography, futures workshop, grounded innovation, learner-centered design.

1. INTRODUCTION

Mobile times! Within a fast moving society we are always on the run. A substantial part of our lifetime we spend in traffic. Innovation literature reports, what is the "job done" by milkshakes in the morning (Christensen et al. 2007): To kill time of driving commuters – a low form of entertainment for a hand and a mouth during a dull drive to the workplace. But even in public transport where the hands are not handicapped by a steering wheel one may observe a rich variety of useless distractions from those mobile moments.

Still, since the invention of the book contributed to the history of portable media several formats of tools and interaction techniques enable mobile learning. In particular students whose job is to learn with limited resources populate public transport with learning activities, but rarely they find ideal conditions. Thinking of suitable, learner-centered media and environmental conditions, not only instructional methods, but also individual learning goals, strategies, preferences and contents have to be taken into account.

This paper begins with a discussion of such impacting factors known from the literature and introduces the conceptual ancestors of our methodological approach to develop new concepts for mobile learning. Within a class on strategic user research several methods of observation, data analysis and idea generation have been applied in order to understand and differentiate mobile learning activities and media usage in public transport. During the observations we looked into learning motives, educational contents, and recurring problems of commuting students. The empirical data from observations provided the basis for the systematic generation of ideas how to address these problems within a futures workshop. The empirical and the development approach and their results are described. One main opportunity to design mobile learner-centered systems was identified around the attempt of mobile learners to sustain a comfort zone and familiar environment for learning in public spaces. Based on the empirically collected requirements and ideas from the future workshop we elaborate upon a concept for a mobile system sustaining such a scaffolding learner-centered environment. We describe the system design for an iDesk prototype and illustrate its use through a fictional usage scenario. Final conclusions sum up the project and its results and reflect upon lessons learnt with impact beyond the scope of this project.

2. RELATED WORKS

Mobile learning involving portable devices has been described as “learning across contexts” (Walker 2006), but the notion of context remains disputed in the related works. Portable devices have been discussed as a valuable means to support the context-dependent construction of knowledge (e.g. Jippling, Dieter, Krikker, & Sandro, 2001). Especially their ability to collect data, to work collaboratively and location awareness features are suited to create uniquely new learning opportunities (Patten, Sanchez, & Tangney, 2006). Learning may be understood as expansion into a context where meaning-making practices and objective opportunities for development relate. Systems may provide opportunities for learners to expand their abilities for engagement in a given environment (Breuer and Matsumoto 2008). Still, in many cases learners just want to utilize commuting times for learning purposes. Following this assumption this work continues a series of works intended to explore and design formal and informal learning environments (e.g. Breuer& Matsumoto 2011). The research and prototype we describe resulted from a university class on advanced user research.

3. RESEARCH DESIGN FOR GROUNDED INNOVATION

Grounded innovation generates empirical data from multiple perspectives on a roughly defined design space and takes its analysis as a basis for the proposition of qualified opportunities for innovation (Breuer & Steinhoff 2010). In this case we looked for new ideas and concepts how to support self-initiated learning activities of commuters. Ethnographic observation and a diary study provide the empirical problems we addressed within a future workshop on mobile learning. One of the resulting idea clusters addressed the difficulties of commuting students to sustain a familiar comfort zone for their learning – the iDesk prototype was then specified to conform with the requirements derived from the empirical studies.

3.1 Participatory Observation and Diary Study

In order to understand the requirements of mobile, especially commuting learners we set up and conducted a user diary study and day-in-a-live visits. Focusing on the observation such ethnographic methods are suited to identify problems and opportunities beyond the ones that are accessible through interviews and to the participants consciousness. The participants of this study were 19 female and 27 male students between 24 and 36 years old studying interface design, industrial design, history, literature, social studies and medicine. Regularly commuting 30 to 90 minutes between their homes in Berlin and universities in Potsdam they all share a common interest in utilizing commuting times for learning purposes.

The first task and step in the document "day in the live study" we interviewed the participants on demographic data and about their mobile learning activities. We wanted to find out which utilities they use, which method they prefer to learn when they are on the move, their learning places or their preferred learning time. In order to understand their learning context we asked about their actual learning topics and goals, and purpose (e.g. an exam or an applied design task during the semester). After the interview we began with the observation. Observers from the class accompanied the participants for several hours trying to find out insights about mobile learning routines and behavior. The task of the observers is to document their observations and thoughts. The forms of documentation include photographs and illustrations attached to the written protocols, notes and interviews. An observation guide put focus on media preferences and ways to organize mobile learning including not taking and use of utilities to support mobile learning through pencils, post-its or digital devices. Questions we tried to clarify through the participatory observation were: Where do students learn? How they practice mobile learning? When they are learning? And in which constellation they learn? Beside the general observations observers make memos or notes of ideas, for example: "Simon memorizes lot of thoughts through shortcuts". After the observation we conduct a second interview to explore individual learning preferences and habits further based partially on our observations through questions such as: If you have to research, how do you proceed? Why do you choose this particular way? Why are you learning while on the move? We also asked the participants to draw their personal learning network including the kinds, contents, frequency and strengths of connections. Participants also rated their learning media after importance yielding the book as the most important.

Finally the learners were asked about their personal schedule, e.g. how much time they have to learn for an exam. We also ask about the time the learners use to learn on the move or they private desktop.

In addition to the day in a live study we gave out user diaries to get insights into mid term developments that cannot be observed live by a dedicated observer. In a user diary participants document notes or observations from instructed self-observation. In our case the aim of the user diary was to find out how people organize their learning day when they are on the move. Participants write down for one week how they learn when they are not at home. We also wanted to know something about their different and preferred learning places and the problems and disruptions within each context. The study should also reveal what they carry with them, what they learn and which kind of topics. First the participants were also interviewed about their learning behavior, especially the learning on the move. For example: How you plan your learning activities? During the documentation the participants answer a set of questions at the end of every day. They document their times and place of learning and their preferred utilities, media, and methods for each. At the end of a day participants construct a learning curve in a given diagram summing up places, time of learning, sleeping phases, concentration phases and learning success. They rate their capacity of learning and their concentration, and in how far they reached their learning goal or less than what they intended.

3.2 Data Analysis and Aggregation

After the observations and receiving back the user diaries data analysis and aggregation started oriented on principles of adductive thinking as developed in Grounded Theory (Glaser & Strauss 1967). Following an approach of "Grounded Innovation" (Breuer & Steinhoff 2010) and "Divergent Innovation" (Breuer, Hewing, Steinhoff 2009) we structure the design space of mobile learning in order to create innovative concepts. First we inspect all data and note first impressions and insights to get a first idea of mobile learning. After first inspection we could categorizes our notes and phrase first codes from that. These codes are the basis for our first hypotheses about mobile learning. Through repeated viewing of our data we refine our knowledge and insights of learners. Open coding results in memos and a list of codes. Finally the codes are sorted. Four categorizes resulted: motivation/purpose, situation/places, material and problems. At the end we formulate a thesis including proposals for design concepts and descriptions.

The motives to mobile learning are different. Some students are learning to save time and to use their time effectively: "What I can learn on the move, I do not need to learn at home." Another motive for learning is boringness and the wish to bridge the time gab. Other participants mentioned feeling alone at long learning hours at home and therefore attending the library (besides from more flexible access to books). Most learners actively pursued or constructed their own motivating learning environment.

Students study almost everywhere; places include the library, cafés, parks, and fitness-studios, learning groups, bureau or public transports. The times to learn in the public transports are short, between 10 to 40 minutes. Apart from library, where learners typically spend hours to study complex topics, students learn less complex themes when they are on the move. They use the time to repeat the suspect matter or to read less complex themes. They repeat previously learned content, learn vocabulary, read or take notes and deal with SMS or calls. Preferred media are books, files or flash cards or notes and post its. Mobile phones, audio player and laptops were rarely used.

The observation and the user diary reveal that learner have some problems during mobile learning. Due to the available media and the environmental sound all learners complained about frequent disruptions. The most used media on the move are books. But they use books because of missing alternatives. Laptops are often too heavy and too unhandy for using on the move. Students also are often missing fast, reliable and affordable internet connection for further research. Books on the other hand lack further research possibilities. Another constraint for learners due to weight is that they have to decide which book they take to read on the move. Therefore they can use only a little part of their preferred learning material. Disturbing environmental noise in the public transports includes other people speaking on the mobile phone and operational noise of the means of transport. In the library the unsettled atmosphere and typing of other learners on their laptops was perceived as disturbing. The learners were disrupted when they are on the move during the public transport through the announcement or changing the trains. Often they are in a hurry and put their material in their bags very hasty. "After some turns of tearing the print articles out of the backpack and putting them back in a hurry they mutate into a paper ball with poor readability." Other disturbances are noise by other people or music by headphones. Several participants felt uncomfortable about the closeness to

other people and the general unsettled and foreign situation, by contrast to their homely environment. That's why they try to isolate them from the noise, for example with headphones that help them to create their own (virtual) audio environment. In general we could observe that the learners experience mobile learning as a disruption from their learning at home. That's why they try to organize a fluent passage between their home desktop to mobile learning. Some cultivated their own symbols or systems to work on the move: "If I read a text, I use small symbols. At home, I see through the icons how I have to continue learning. For example, I use QG, that means look at Google, QL look at Leo and QA, look at the ACM portal." Other students use own symbols to sign text passages of interest. A further kind of organization was to categorize their learning material and plan what they learn on the move to use the time gap.

The coding of the data and its categorization into emerging categories allowed developing first concepts and the following core categories: The learner will be affected by different outer influences during their mobile learning. They didn't have the optimal learning environment like the one they created at home. They try to simulate their home environment. One core aspect we then conceptualized as a need for a personal "comfort zone", to make their situation on the move pleasant as possible and to support the learner. Further more, the learner have to use analog media instead of the digital media most of them would have preferred. Available digital media do not suffice to support learners due to weight and limited internet connection. Participants required a means that supports them on the move, containing aspects of analog media and additional aspects of digital media to support the workflow between mobile and home learning at their home desktop. A seamless transition and passage between both situations appears most promising.

A digital learning device like a tablet PC can support the learners at their studies. A wireless internet connection is needed for additional research and constant availability of learning materials, the possibility to take and exchange notes and processing, and the availability of interactive learning materials. Such a compact device is a combination of the benefit of analogue media and an e-learning platform: handiness, contextual study and research on the move and processing of subject matter.

3.3 Ideation Design and Futures Workshop

Ideation Design applies divergent and convergent thinking (Edelmann 2003). Principles of detour (Breuer, Hewing, Steinhoff 2009) involve the idea that "function follows form" (Goldenberg, 2003) and apply external points of reference in order to enable multiple shifts in perspective. Within futures workshops we detour through a utopian stage without limits in order to come up with desirable solutions to problems or opportunities in reality. A futures workshop can be interpreted as catalysis for reducing the discontent with a current situation and for showing positive development possibilities for the future (Jungk & Müllert 1987). Normally, a futures workshop lasts several days and is subdivided into three sequential process phases: the critique phase, the utopian phase and the realization phase.

In the first phase of our future workshop, participants collect problems as well as resentments and make comments on dissatisfactory situations within a specific subject area. Since most of the participating students commute daily between Berlin and Potsdam, the strengths and weaknesses of mobile learning were a topic of common interest. The illustration of problem fields by formulating negative news headlines is an appropriate way to make the significance of a problem and its implications for the future evident. By individual evaluation, relevant problem complexes are being selected for the next phase. The topic of this particular futures workshop was "Mobile Learning in Public Transport". In the utopian phase, it is assumed that any limitations of real life are not valid and that, in principle, everything is possible. Hereby, participants portray an exaggerated picture of the future driven by desire. The problems of the critique phase are being reformulated so that they result in a positive statement, e.g. positive future news headlines. Possible solutions are being identified. The neutralization of any limitations stimulates unusual and unconventional ideas and solution concepts. The third, realization phase, re-establishes the connection with the world as we know it. The ideas and solution concepts of the utopian phase are being critically examined. The participants analyze how single aspects of the utopian vision can be realized in reality. Especially, the needs on which the utopian visions provide starting points for the realization with today's and upcoming means, e.g. technologies.

Our futures workshop was prepared based on the ethnographic insights and learning barriers from the observation and diary studies. After the introduction the participants were shown a short film as a warm up. In the following phase of critics the goals and regulations were explained to the participants in order to make them conscious of their role in the process and the task. The participants could now begin to collect problems

and critical points of mobile learning by acclamation, each of which was noted to ensure that everyone got a precise overview of the problems of the subject. All collected critical points were subsequently arranged into four categories in order to make the most important problems more conscious. The participants were now divided into four teams – each team was assigned with one of these categories they should specialize in and work with in the following utopian phase. After an introduction into the utopian phase (goals, tasks, regulation), four tools were explained more closely (brainstorming paradox, adaptation, buzz word analysis and method 635) that could help to develop ideas in an unconventional way. Each team developed a utopian vision with the creative technique. They could consult a teaching moderator for questions and support. After this phase each team should evaluate its own utopias. Each participant had three points to rate an idea. The three utopias that got the best evaluation were presented to the other teams. The phase of realization began by outlining the goals of the phase. Each participant had four votes to give for the best solution of the utopias presented above. The results were evaluated. Each group had the task to realize one solution that would be possible to bring into being with the technical possibilities of today. Each team presented in the end its solution or the exact description of its concept. All four ideas were acted out through an informance to the group and discussed in the end of the workshop.

We selected this best idea grounded in the empirically driven innovation approach as a basis for system design. It provides a solution to the problems of students with distractions and disruptions during their mobile learning activities, and strengthens their weak attempts to sustain a familiar and comfortable learning environment in public space by means of sophisticated software for light weight tablet computers: a personal library or iDesk design. The iDesk ought to offer the possibility to depict the complete learning environment virtually in a handy and easy-to-use format. It provides access to a personalized learning environment, which adapts to the home environment. Among them are graphical illustrations of typical domestic learning venues or their metaphors, like one's own desk, bookshelf, files and other objects ready for interaction on the tablet.

4. DESIGNING A LEARNER-CENTERED I-DESK SYSTEM

The basic idea for the system design is to preserve aspects of formal and home learning environments within mobile settings and intends to support self-directed learning activities during commuting times. The concept utilizes tablet computers with camera and gyro sensor in order to create a personal or shared space for learning. An iDesk device is a tablet-PC like the iPad by Apple enhanced through learner-centered software. An improved but optional device design, however, would provide for two touch screens that can be folded like a book. This does not only have the advantage that the display is protected when storing it in a bag and saving space. The biggest advantage of this design is to ensure natural working like with a book or notepad, which can be opened and is thus adapted to the typical learning media of pupils or students. Furthermore, the two screens can be used in different ways, for example to use diverse contents clearly and separately from one another. The device also contains a stylus by which handwritten notes can be made and text passages marked, for example in a book or other things can be done with it. It supports familiar ways of working and learning with analogous media and methods.

After starting the device, a segment of the learning environment is depicted at first, for example the picture of one's own desk with all filed media, like books, notepads, learning cards, and such – everything which is also typically on the home desk within reach. By moving the device in different directions, it shows parts of the home learning environment, similar to a picture frame revealing only a part of the room. Holding the "iDesk" horizontally it shows the surface of the table with different interactive objects. Moving it to the side changes the visible segment, for example to the bookshelf where all previously filed books are depicted and ready to be read. They cannot only be relocated, filed, read or edited within the shelf but also between shelf and desk as direct work space. The operation with the finger or the stylus should work as expected. Scrolling through books or notes is possible by swiping a finger. With the stylus handwritten notes can be created or menu items handled, which can be relocated by moving an application to the other (area of the) screen. By means of this simple principle, the familiar learning environment ought to be imitated in a small, handy format. It is enriched with mobile features like wireless Internet access, telephone function, savings possibilities, data collation, calendar management, notes, email, and such, also allowing a seamless transition between analogous learning and educational multimedia.



Figure 1. Different sketches of the interface. View on the table, some files and an opened book, ready to read.

4.1 Experience Prototype

The current system, as described in the following, builds the requirements of the participants in the empirical study. We found that students predominantly learn analogously in an individual learning environment (mostly at home). Learning on the go, predominantly on trains, buses, in the café, gym or library would be a great advantage for many for reasons of time saving and motivation. But mobile learning is limited through several factors: On the one hand, books and notes on the go are simply too unhandy or heavy and even the possibilities for a quick research on the Internet are not given. Problems of space for learning media on the go and the insufficient offer of educational computers or suitable devices make additionally sure that mobile learning only takes place to a limited extent.

The iDesk described closer in the previous chapter, could fill these gaps and allow for what the investigated test persons were missing. The added value of such a device is to allow mobile learning in a learning environment, which is based on the home environment and can be adapted fully to one's own needs. It is suitable for the different learning contents and times (more intensive learning even with other learners over a longer period of time as well as for shorter times, e.g. a 10-minute bus ride). It offers the possibility to create one's own comfort zone in isolation from disturbing ambient noises.

4.2 Hardware

The iDesk must adhere to different requirements to the hardware like weight. Investigating and comparing the average weight of books, mobile phones, tablet-PCs and net books, a weight of not more than 500 grams seems to be optimal, because thus the device can still be held in one hand for a while without feeling tired. At least 10 hours duration for permanent operation should be possible, on stand-by-operation this value should be many times higher. It should be easy to switch the iDesk on or off or put it in stand-by since quick changes of location and a quick activation of the device are essential. Besides WLAN or the possibility to go online per UMTS to be able to research on the go and send emails, the integration of a video camera is planned to enable collaborative video telephony via Internet. The possibility to get in touch with other learners per video telephony via Skype from the home PC, is a basic requirement for the iDesk to make collaborative learning and the exchange with other learners possible on the go. Additional interfaces like Bluetooth for a wireless connection of several devices, a USB-connection as well as an SD-card slot are important to be able to load and install data from other media.

4.3 Interaction Design

Requirements for design, which the software must meet, are just as complex because they must make the analogous data like books tangible on other media, enrich them with interactive possibilities without limiting the user in any form if they want to adjust the software individually in addition.

Basic activities to be carried out with the iDesk are: Reading, writing, marking, taking notes, information retrieval on the Internet, writing email, creating files, comparing data, administering, searching and copying. Individual adaptability of the software supports users in recreating their personal home learning environment and familiar interaction patterns. One possibility to depict this collection of demands in one single device is through controlling by gestures. For instance, holding the tablet horizontally, the surface of the desk with all

its documents is shown; more parts show up when the tablet is moved to one side. Keeping the iDesk vertically, a bookshelf and additional contents can be shown depending on how and in what segment the device is moved further on. Detailed working on documents, reading books, and such can be done by the help of the stylus or by counteracting with one or several fingers.

Two screens would offer additional possibilities to arrange one's documents on the device. Two documents can be displayed next to one another or an opened page takes up both screens for a better picture by turning the device vertically. To prevent unwanted changes of the display detail when holding the device (for example for a quick change of the seating position on the bus), the display detail can be fixed by pressing a key. This option is also necessary when working on documents in a certain position. In order to synchronize documents of all kinds as well as the learning environment, e.g. one's study desk with the iDesk, the method of visual search is employed (a more simple initial version may apply barcodes). Documents or even entire shelves can be scanned. These data are filed away, identified and transformed in form of photos on the iDesk so that they can be worked with further on. A usage scenario illustrates how to work in such an environment.



Figure 2. Scanning documents

4.4 Usage Scenario

Jessica is 23 years old and in their 6th semester of social pedagogy and English. She has to learn for an exam. First she is learning at home, after she goes to a fitness studio by bus. Later, she attends a meeting with fellow students to learn for the exam. At home Jessica is learning vocabulary and English grammar by a workbook where she fills out fill-in-the-blank-text. In addition she reads English literature. In the book she is editing important words with a pen. Before leaving the house she packs her stuff together and synchronize her stuff with iDesk. On the move she wants to repeat their vocabulary. She needs one book for the meeting with her fellow students. Cautionary she takes also her fill-in-the-blank-text away, when she have unexpected waiting time. On the move she has a 25-minutes trip with the bus to fitness-studio. During the trip she opens her iDesk and starts her vocabulary trainer through a smear gesture. The first vocabulary card is shown. Through smearing she turns the card and gets the answer. Before she reaches the stop, she has a look to her tasks for the day. She pushes the trainer away and zooms into her notes with two fingers. With the help of a strike out gesture she closes the vocabulary task. At the fitness studio she uses iDesk like a book. While running she reads and highlights important words through smear gestures. With a circle gesture around words she gets a menu with related tasks like copy or paste. Afterwards she studies vocabulary and listens to the pronunciation visa audio. On the way to her fellow students she searches and browses with iDesk for books on the Internet. At the library she meets her fellow students for learning together for their exam. For that they lay their iDesks together to one big screen to learn collaboratively on one document. One of the students is writing, another is handling with the document and another is editing words from the books can be copied to the document. Afterwards each one studies individually and takes notes with handwriting technology.

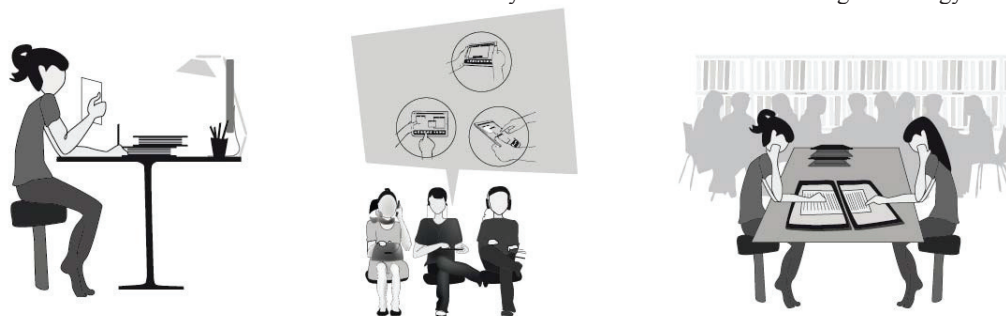


Figure 3. From left to right: Learning at home, Bus ride working with the iDesk and meeting in the library

5. CONCLUSIONS

The research and development methodology and the project results demonstrate a showcase of grounded innovation (Breuer & Steinhoff 2010), which was based on empirical observations, interviews and diary studies. Starting from an empirically based understanding of learner-centered requirements commuting students and the design space provided by mobile devices we identified, qualified and specified opportunities for innovation

Analysis of the empirical data yielded the maintenance of personal comfort zones for mobile learners as a new and valuable opportunity for learner-centered interaction design. Beyond the basic idea and concept the empirical research and findings especially from the utopian phase of the workshop contributed a rich variety of insights and user requirements to the specification of the prototype that is currently under development. A personal library and iDesk system were designed based on this insight and ideas generated within a futures workshop. The prototype that was developed accordingly applies gesture-based handling of tablet computers in order create an adaptable and comfortable personal learning environment with individually adaptable and familiar modules.

Since the printed book and later portable computers created a market for mobile learning means technological capabilities develop rapidly. The challenge persists to design and employ them in meaningful ways for users and learners.

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